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AD2-I20-A049

6mφ Radiometer Space Chamber

Users' Manual

Advanced Engineering Services Co., Ltd.

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Appendix A

1. Introduction

This users' manual is to provide necessary information to the users of 6mφ Radiometer Space Chamber (referred to as "this facility" hereafter) located in the 6mφ Radiometer Space Chamber Building.

This facility is used for optic tests on different kinds of earth observation radiometers to be mounted on satellites, or thermal vacuum tests on mid/small-size satellites and satellite components, in simulated space environments on ground.

This facility can reduce the transmission of micro tremors from the ground or the vibration from vacuum pumps, etc. to a test specimen (■abbreviated as TS hereafter) to the maximum degree, by adopting an isolated base, so that high-precision optical instruments, etc., can be the subject for a test. Furthermore, this facility achieves space with high cleanliness, with its design to satisfy the cleanliness requirements for optical instruments while dealing with both particulate and molecular contamination.

The major environments in outer space are high vacuum, cryogenic shade, etc. On the geostationary orbit which is about 36,000 km above the surface of the earth, those environments respectively reach the levels of about 1.3×10^{-11}Pa and 3K, the latter being an infinite heat absorber.

However, it is financially unfeasible to simulate such environments on ground as they are, and therefore this facility provides vacuum pressure of 1.3×10^{-4}Pa or less and shroud temperature of 100K or lower. In order to meet the request of temperature planes to be 100K or lower, meanwhile, this facility is equipped with hard ports to mount a space background panel, as well as a He refrigerator and a He supply flange which cool down the panel plane to 20K.

We can verify the reliability of satellite behaviors in space by extrapolating them from the accuracy assessment on thermal designs under the simulated environments mentioned above.

2. Brief Overview of this Facility

2.1. System Outline

The external view and system diagram of this facility are shown in Figures 2-1 and 2-2, respectively.

Figure 2-1 External View of 6 mφ Radiometer Space Chamber

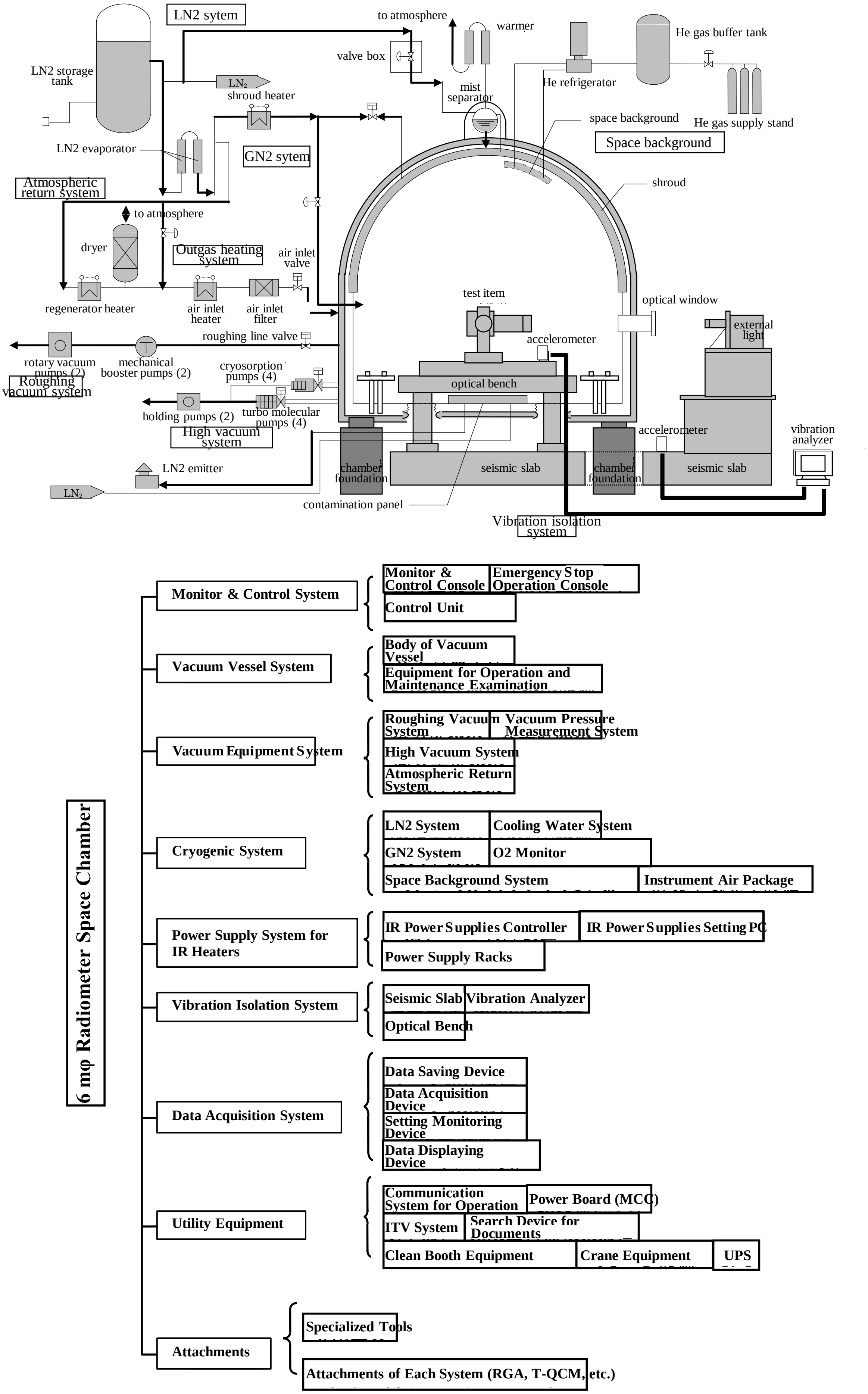


Figure 2-2 System Diagram and Tree Diagram of 6mφ Radiometer Space Chamber Facility

2.2. Main Specifications

The main specifications of the whole facility are shown in Table 2-1.

Table 2-1 Main Performance and Facility Specifications of 6 mφ Radiometer Space Chamber

item	performance/specifications	notes
(1) space chamber	mailbox type	
(a) usable dimensions	6m (dia) × 8m (L)	dimensions inside shroud
(b) access door of chamber	6m (W) × 5.1m (H)	incl. dolly
(c) shroud temperature	100K or lower, or ambient temperature ~ 60℃	
(d) Max. weight carriable in chamber	4,000 kg	incl. jig
(e) vacuum pressure		
① operational vacuum pressure	1.33×10^{-4}Pa or less (1×10^{-6}Torr or less)	
② ultimate vacuum pressure	1.33×10^{-5}Pa or less (1×10^{-7}Torr or less)	*1
(f) pumpdown / repressurizing time	8 hours or less	
(g) Max. consecutive operation days	45 days	for 1-min. sampling cycle
(h) black space	95％ or more	when using supporting bench with cooling panel
(i) space background temperature	20K or lower	
(2) power supply for IR heaters		
(a) power supplies for heat sources	4 racks	6mφ 60W power supply rack-1: 25 6mφ 2 kW power supply rack-1: 10 6mφ 2 kW power supply rack-2: 10*2 6mφ 3 kW power supply rack-1: 10
(3) vibration isolation system		
(a) optical bench dimensions	4m × 6m × 0.5m (D)	permanently equipped in chamber
(b) optical bench eigenvalue	30Hz or higher	
(c) relative displacement vibration	1.0 μm 0-P or less	bet. bench in chamber and slab outside
(d) relative angle vibration	0.3 μrad P-P or less	bet. bench in chamber and slab outside

*1 w/o TS, TS supporting bench, or IR radiation; shroud being cooled with LN_2, within 8 hours after the start of pumpdown.

*2 2 kW power supply rack-2 and power supplies-3, 4 are not available.

2.2.1. Monitor and Control System

This system enables intensive monitoring of the operational status in the space chamber via Human I/F Stations (HIS) based on the process data of the vacuum equipment system, cryogenic system, etc., collected in the DCS control station (Figure 2-3.)

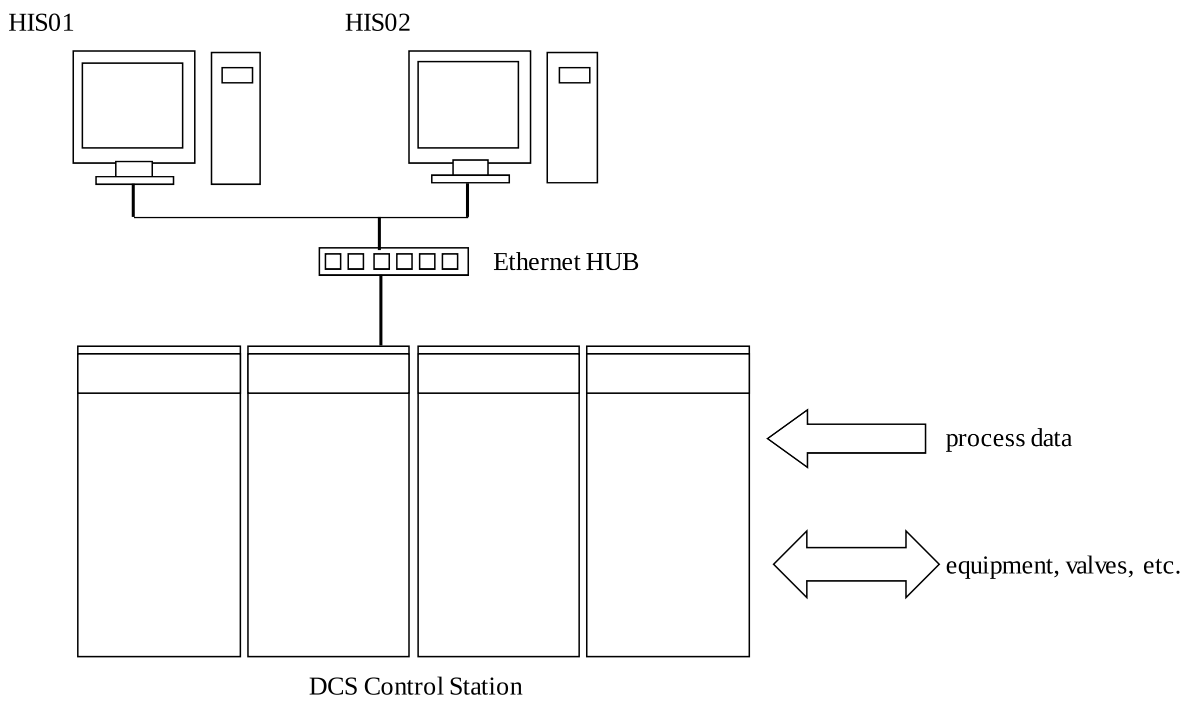


Figure 2-3 Diagram of Monitor and Control System

2.2.2. Vacuum Vessel System

This system consists of a vacuum vessel and equipment for operation and maintenance. The brief explanation of the system is provided as follows.

(1) Vacuum vessel

This cylindrical stainless-steel vessel is shaped like a mailbox, and has a storage space of 6-meter diameter × 8-meter long (inside shroud.)

The mailbox-like shape of the vacuum vessel achieves a spacious working area and easy access to a TS.

The vacuum pressure inside the vessel is measured by the Pirani gauge and ionization gauge mounted on the vessel. Their measurement ranges cover successive measurement from the atmospheric pressure to the ultimate vacuum pressure range, and the data is displayed on the control and monitor console in the measurement and control room. They are also capable of continued measurement during power failure, with the help of an uninterruptible power supply system.

The vacuum vessel has optical windows to be used for radiometer optical confirmation tests on both sides of the vacuum vessel body part and the access door for a TS. There also are windows for alignment measurement on side and top of the body part, and on the access door.

The alignment measurement windows have mounting seats for the ITV facility (cf. section 2.2.8) to monitor the inside of the vacuum vessel.

(2) TS installation device

The TS installation device is made up of a moving dolly, a TS installation dolly, and a supporting bench with a cooling panel (or a supporting bench w/o a cooling panel.) The moving dolly and the TS installation dolly can be moved with human power, owing to the air bearings attached to them which slightly lift them up. Each of the dollies is briefly explained below. As for how to operate the TS installation device, refer to 3.3.1.6. Its external view is shown in Figure 2-4.

(a) Moving dolly

The moving dolly can freely move in the preparation room with the TS installation dolly, the TS supporting bench, and a TS mounted upon it. It also has a bridge board for moving the TS installation dolly onto the optical bench in the vacuum vessel. Its brief specifications are shown below.

Table 2-2 Basic Specifications of Moving Dolly

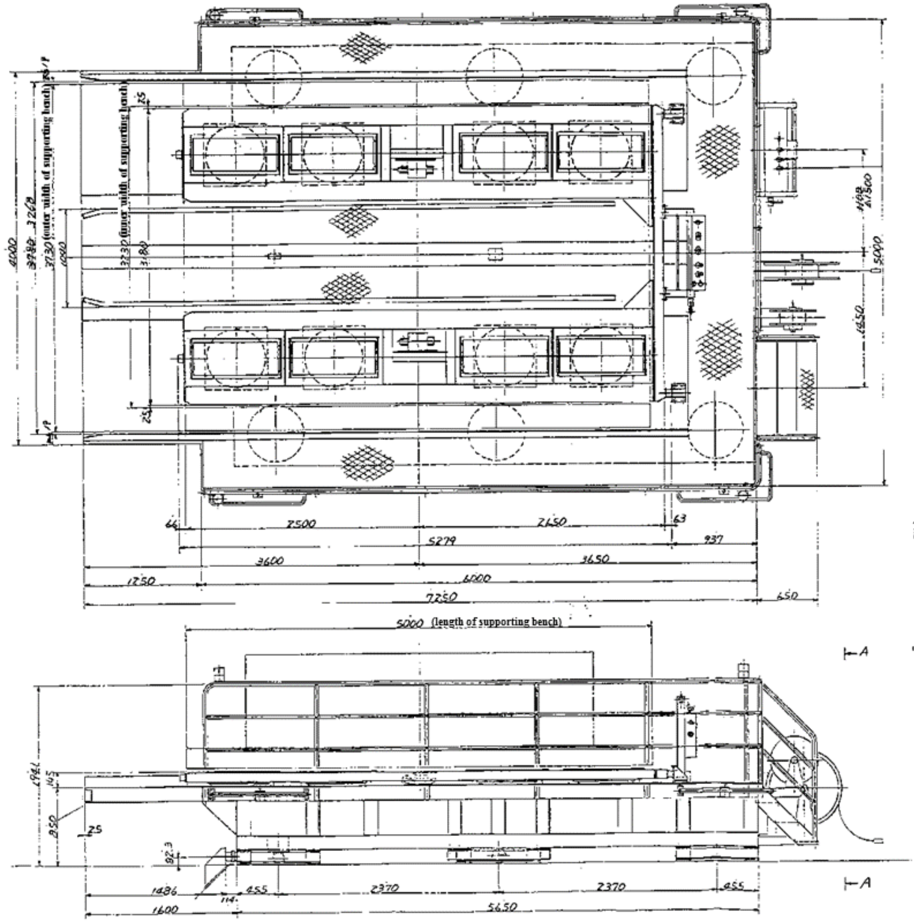
item	specification
dimensions	5m (width) × 7.25m (length) × 0.85m (height) (from floor surface)
load capacity	Max. 12,400 kg (incl. TS and jig = 4,000 kg)
own weight	7,700 kg
drive system	pushed by hands
movable range	unpacking room, preparation room
length of air-supplying hose	30m
movable load (Max. pulling force)	Max. 52 kg
air consumption	2.0 Nm^3 / min
air pressure	0.39 MPa or more

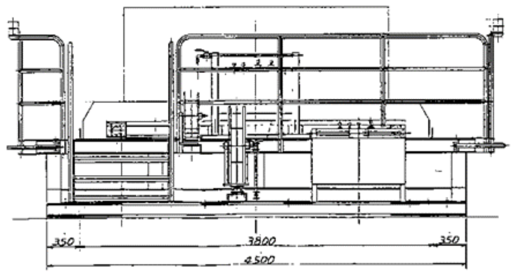
(b) TS installation dolly

The TS installation dolly is used for mounting and dismounting the supporting bench with a cooling panel or the supporting bench without a cooling panel from/onto the moving dolly onto/from the optical bench in the vacuum vessel. The basic specifications of the TS installation dolly are shown below.

Table 2-3 Basic Specifications of TS Installation Dolly

item	specification
dimensions	3.19m (width) × 5.16m (length) × 0.145m (height)
	(to the upper end of the jack)
load capacity	6,800 kg (incl. TS and jig = 4,000 kg)
own weight	2,100 kg
drive system	pushed by hands
movable range	moving dolly ~ on the optical bench inside the vacuum vessel
length of air-supplying hose	10m
air consumption	2.0 Nm^3 / min
air pressure	0.39 MPa or more





view between A-A

Figure 2-4 External View of TS Installation Device

(c) TS supporting bench

Those supporting benches are used to mount a TS to place it inside the vacuum vessel. That is, a TS is carried into the vessel by a TS installation device to be placed on the optical bench, while mounted on a supporting bench all the way through. TS supporting benches can be mainly classified into two kinds; one is a supporting bench with a cooling panel used for thermal vacuum tests, and the other is a supporting bench (for optic tests) used for optical performance confirmation tests. The basic specifications of the former are shown in Table 2-4 and Figure 2-5, while those of the latter are shown in Table 2-5 and Figure 2-6. As can be seen from Tables 2-4 and 2-5, their load capacities withstand a TS (including a jig) weighing up to 4.0t. Information on the I/F, e. g., the diameters of the screw holes of hard ports, etc., is provided in section 3.3.1.3.

Table 2-4 Basic Specifications of Supporting Bench with Cooling Panel

item	specification
dimension	5m (width) × 3.5m (depth)
Max. load mass	4,000 kg
mass of body	about 2,800 kg
material	aluminum alloy
surface temperature	100K or lower
	(two out of the LN_2 lines for cooling parts of a TS are used)

Table 2-5 Basic Specifications of Supporting Bench

item	specification
dimension	5m (width) × 3.5m (depth)
Max. load mass	4,000 kg
mass of body	about 2,200 kg
material	alluminum alloy

2.2.3. Vacuum Equipment System

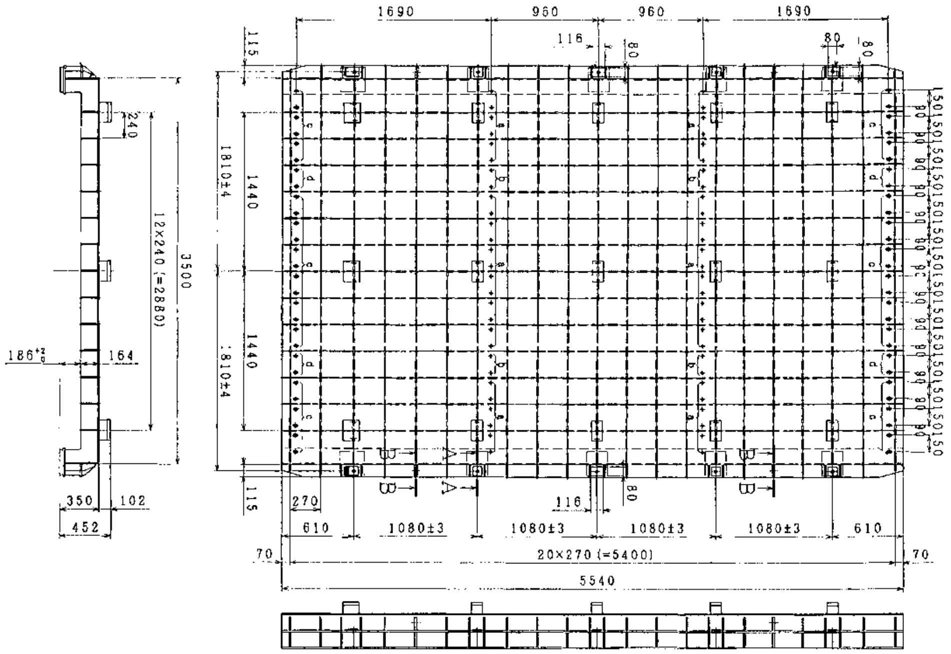
This system consists of low and high vacuum systems which vacuum the vacuum vessel from the atmospheric pressure to the high vacuum, and an atmospheric return system which raises the pressure inside the vacuum vessel from the vacuum state to the atmospheric pressure condition with GN_2 and dry air.

The standard vacuum curve (without a TS) during a thermal vacuum test is shown in Figure 4-2.

2.2.4. Cryogenic System

This system consists of an aluminum-alloyed fin-tube type shroud that is cooled down to 100K or lower by means of LN_2 to establish cryogenic environment, and SBG (space background) cooling lines in the vacuum vessel that are cooled down to 20K or lower by He gas to simulate deep space for radiation cooling. The SBG itself is to be prepared by users. Refer to section 3.3.2.1 for the I/F to the facility. The SBG cooling lines are currently in a dormant state, being not ready for use. Users are to contact the Environmental Test Technology Unit if they want to use SBG cooling lines.

Note) It takes 12 months or longer to get them ready for use.



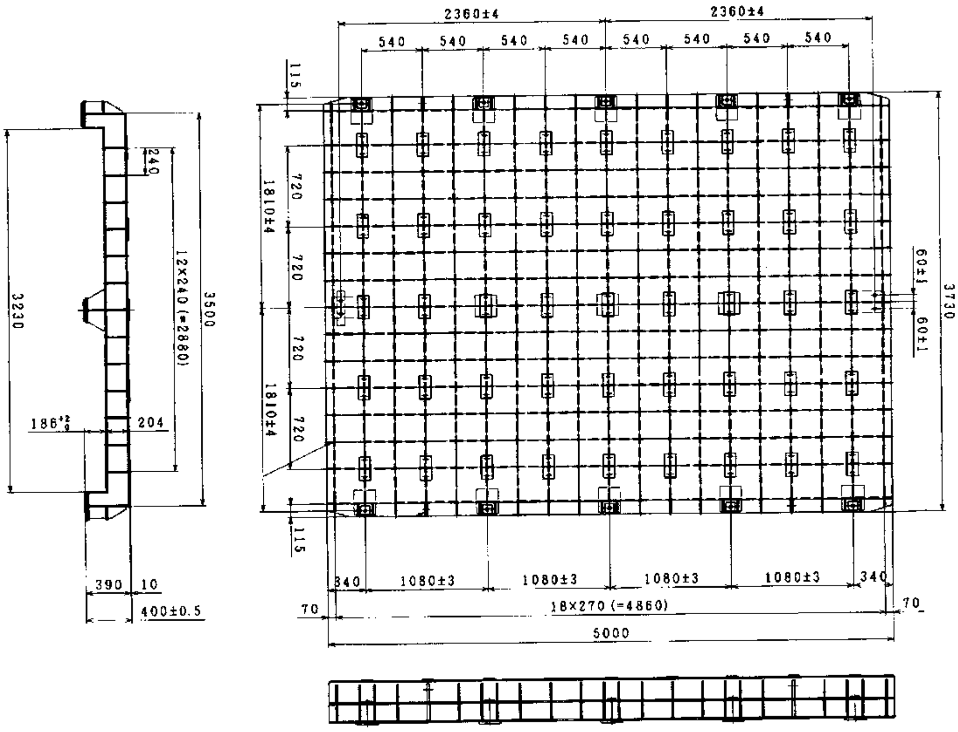


Figure 2-5 Supporting Bench with Cooling Panel

Figure 2-6 Supporting Bench

2.2.5. Power supply System for IR Heaters

These devices are used for IR radiation thermal balance/thermal vacuum tests performed in 6mφ radiometer space chamber, to supply specified EP to IR lamps as the IR light source or heaters which provide external thermal input to a satellite, or to simulation heaters for the heat from the equipment mounted on a satellite.

The test data collected by those devices are transmitted to the data acquisition system in 6mφ radiometer space chamber and recorded thereat.

Table 2-6 Basic Specifications of Power Supplies for Heat Sources

item	specification			
name	6mφ 60W power supply rack -1	6mφ 2 kW power supply rack -1	6mφ 2 kW power supply rack -2	6mφ 3 kW power supply rack -1
qty	25	10	10	10
output voltage	DC60V	DC100V	DC100V	DC100V
output current	1A	20A	20A	30A
output EP	60W	2 kW	2 kW	3 kW
control method	remote control (temperature / constant power / manual voltage output control) / local control			
notes	2 kW power supply rack -2 and power supplies No. 3, 4 are not available.			

6mφ 3 kW power supply rack -1	6mφ 2 kW power supply rack -1	6mφ 2 kW power supply rack -2	6mφ 60W power supply rack -1

Figure 2-7 External View of Power Supplies for Heat Sources

2.2.6. Vibration Isolation System

This system, which is made up of an optical bench, a seismic slab, and a vibration analyzer, is established to avoid the bad influence of vibration that is propagated from outside during a radiometer optical confirmation test performed in the space chamber. The schematic view and basic specifications of this system are shown in Figure 2-8 and below, respectively.

(1) Optical bench (Figure 2-9)

This bench is permanently equipped in the vacuum vessel, and used with a TS supporting bench, on which a TS is mounted, fixed onto the bench. Its main posts are directly connected to the seismic slab via bellows, penetrating through the vacuum vessel, which perfectly insulates vibration from the vacuum vessel system.

Table 2-7 Basic Specifications of Optical Bench

item	specification
dimensions	6m (length) × 4m (width) × 0.5m (height)
mass	about 6,500 kg
material	alluminum alloy (A5083P-O)
structure	integrated with a weld box
main post	6 stainless steel pipes
bellows	stainless steel
surface roughness	25 µm or less
flatness	600 µm or less
eigen frequency	optical bench alone: 30Hz or higher in all the directions
	w/ supporting bench: about 27Hz in Y direction

(2) Seismic slab (Figure 2-10)

The seismic slab is a large slab made of reinforced concrete which is separated from the building foundation, the chamber foundation, and the machine foundation of the vacuum pumps, etc., to isolate vibration from them.

When performing an optical confirmation test on radiometers, etc., relative vibration can be controlled by placing the external light source on this seismic slab, that is, placing the light source and a TS on the same foundation.

- Eigen frequency: 20Hz or higher (for up/down and bending modes, according to analysis)

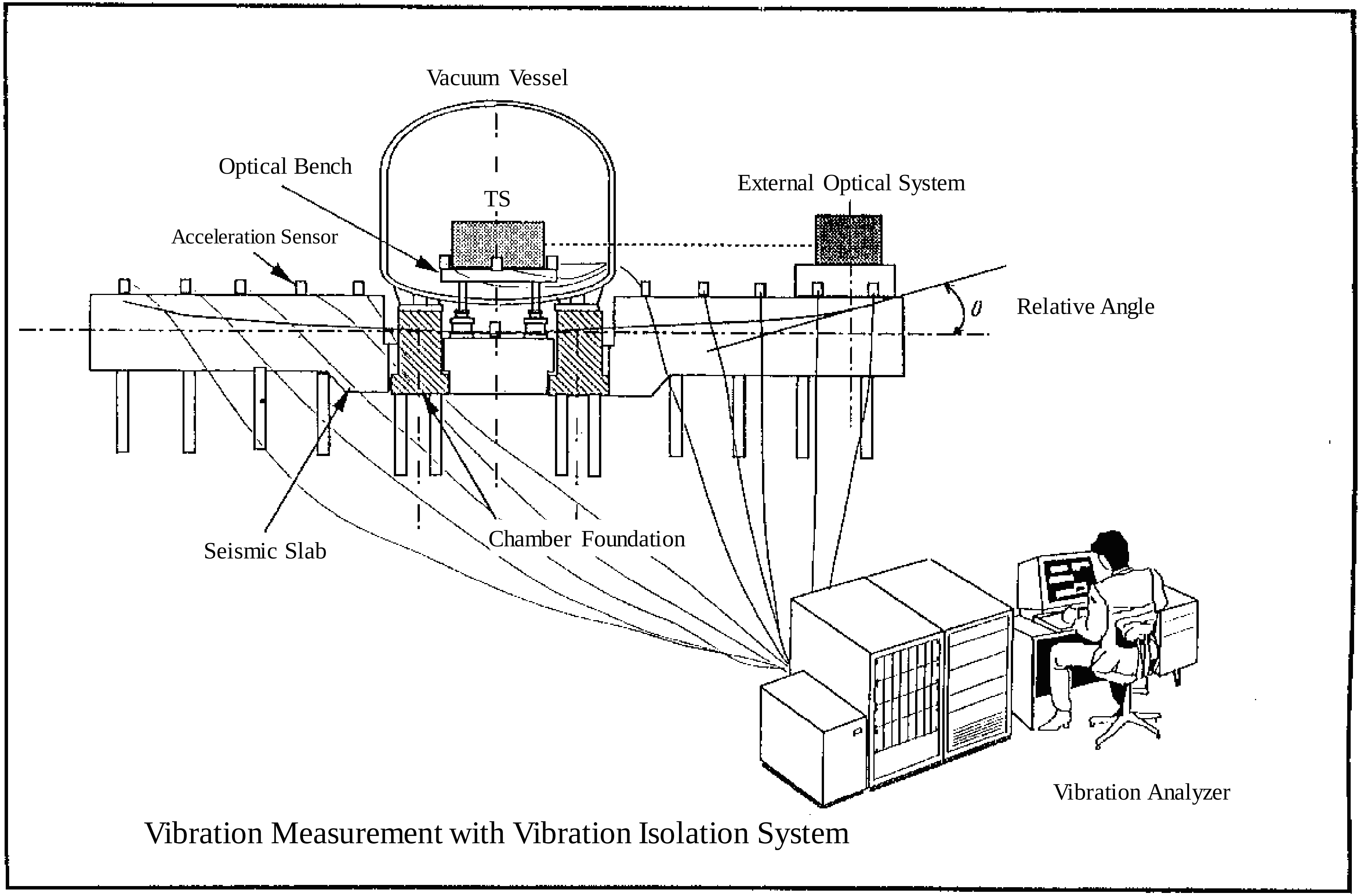


Figure 2-8 System Diagram of Vibration Isolation System

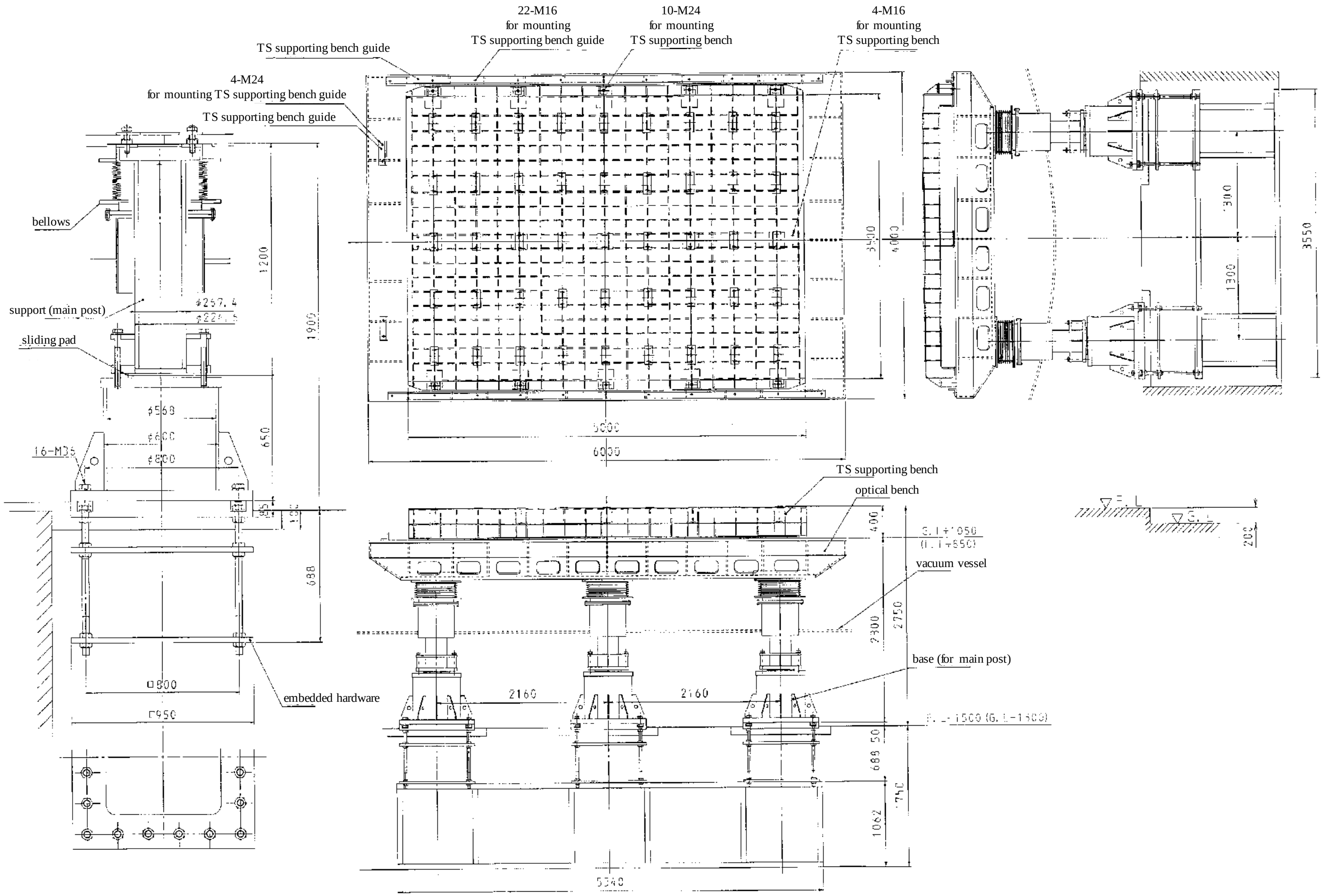


Figure 2-9 Optical Bench

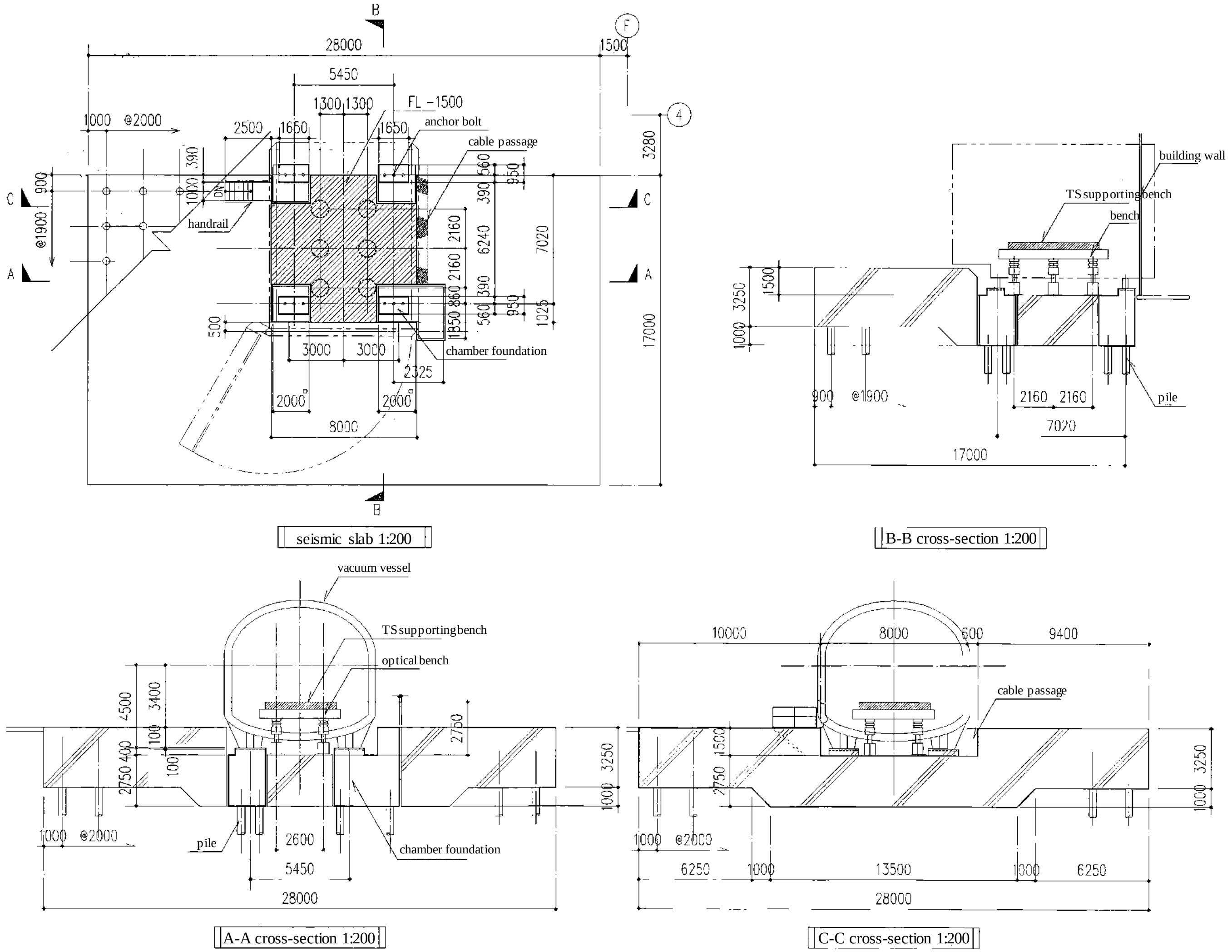


Figure 2-10 Seismic Slab

(3) Vibration analyzer

The purpose of this vibration analyzer is to assess and verify the feasibility of an optical property verification test on a TS especially in micro vibration environments amid the constraints of the vibration turbulence specific to this facility. It is made up of measuring devices, e. g., accelerometers, drivers, etc., and a work station for analyzing data. The basic specifications and system diagram of the vibration analyzer are shown in Table 2-8 and Figure 2-11, respectively.

If it is planned to be used, contact us 6 months in advance, because it requires a prior-to-use checking by the facility-side personnel.

Table 2-8 Basic Specifications of Vibration Analyzer

item	specification
data to be dealt with	acceleration, relative displacement, relative angle
measurement spots	inside vacuum vessel: optical bench, shroud, vacuum vessel outside vacuum vessel: seismic slab, optical window
input	deigital signals via accelerometers
output	output to monitor, or in digital (binary/text)/analogue data
frequency range	1Hz ~ 1,000Hz
number of measurement channels	31 channels (incl.) for accelerometers: 30 chs (inside vacuum vessel: 15 chs, outside vacuum vessel: 15 chs) for laser doppler displacement gauge: 1ch
contents of data analysis	・PSD analysis・transfer function analysis・waveform analysis・FFT analysis
accelerometer specification* cryogenic accelerometer (393M33) 8 sets	measurement range (±G): 2.5 sensitivity (gal/V): 1,000 resolution (μG): 100 working temperature range (℃): －196 ~ ＋121
high sensitivity accelerometer (393B12) 3 sets	measurement range (±G): 0.5 sensitivity (gal/V): 100 resolution (μG): 8 working temperature range (℃): －46 ~ ＋82
high sensitivity accelerometer (393B31) 12 sets	measurement range (±G): 0.5 sensitivity (gal/V): 100 resolution (μG): 1 working temperature range (℃): －18 ~ ＋65
calibration equipment	LV-2100 manufactured by Ono Sokki Co., Ltd. (laser doppler displacement gauge)

* Accelerometers are fixed with heliserts. Pay enough attention to the screw parts, because they can easily be jammed.

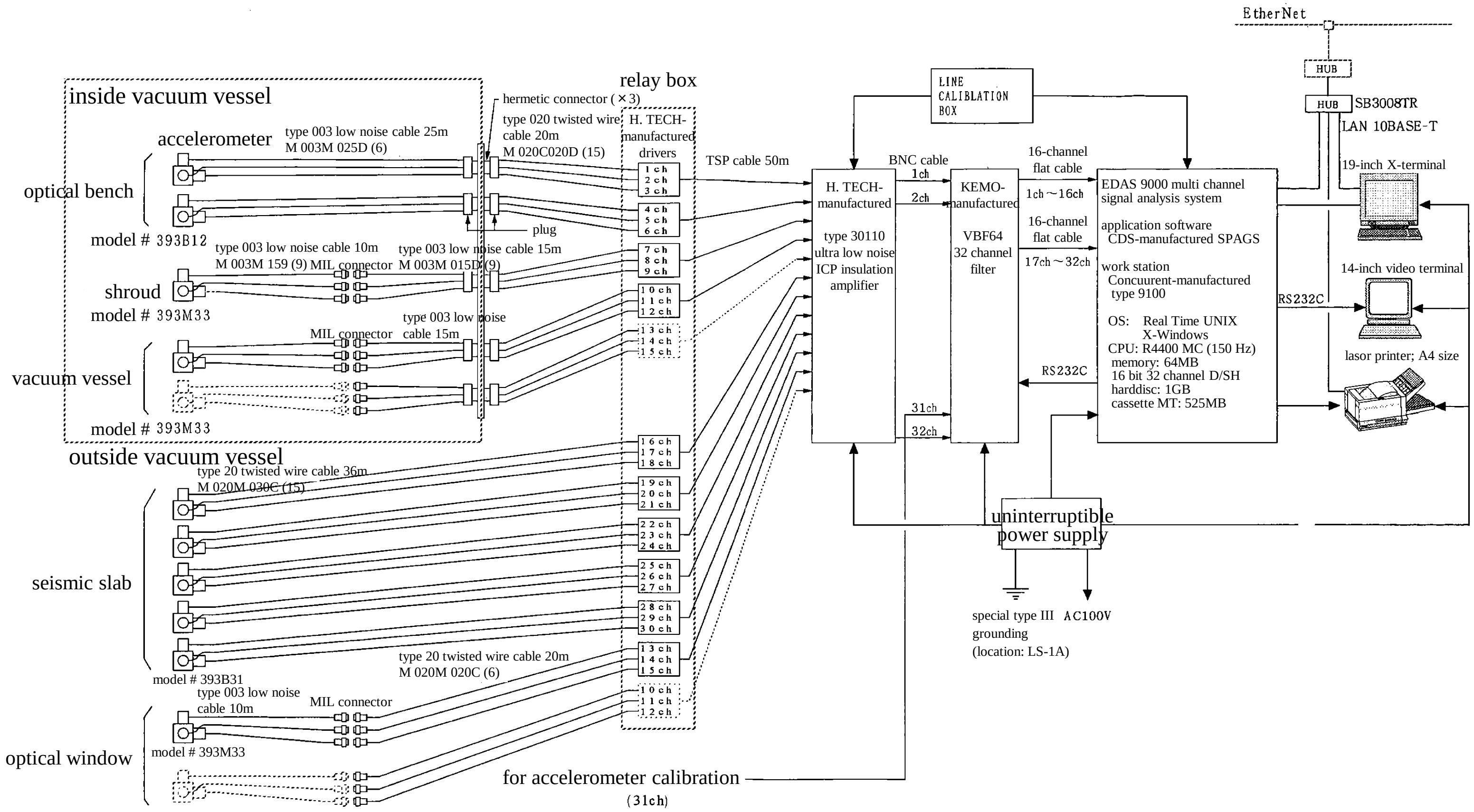


Figure 2-11 System Diagram of Vibration Analyzer

2.2.7. Data Acquisition System

This system possesses a function to acquire, process, and save TS data and facility data during a test on a satellite, etc., performed in this facility, while displaying the data in real time to the operator (viz. monitoring function.) Its basic specifications are shown below. The system diagram of the acquisition system and a correspondence table of thermocouple channels are shown in Figure 2-12 and Appendix A, respectively.

Table 2-9 Basic Specifications of Data Acquisition System

item	specification
Max. consecutive test days	45 days (for sampling cycle = 1 minute)
number of measurement points	thermocouple: 550 chs TQCM: 4 chs
measurement accuracy	(1) temperature: ±1.0℃ uncertainty (incl. thermocouple sensors): 0.9℃ (k = 2) : 1.4℃ (k = 3) (2) voltage: measurement range ± 0.1％
sampling rate	1 time/min OR 1 time/2 mins Min. interval for thermocouple temperature measurement section = 1 sec
compatible thermocouple	T-type

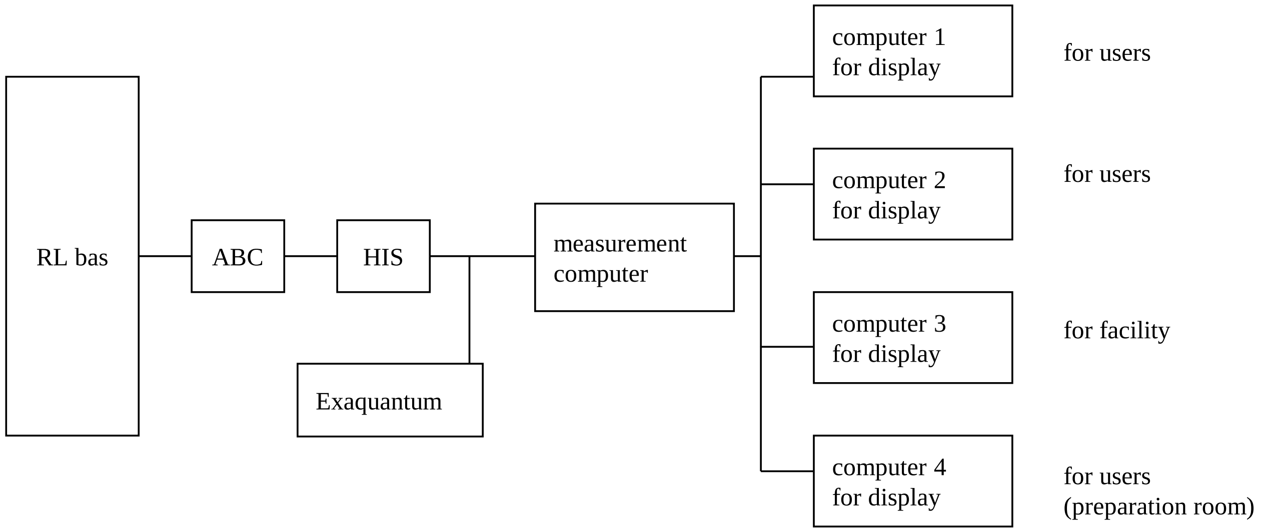


Figure 2-12 System Diagram of Data Acquisition System

2.2.8. Utility Equipment

(1) ITV facility

The ITV facility is a TV system to monitor the ongoing state of equipment and work in this facility from the measurement and control room. There are two cameras with a turning and zooming function installed in the preparation room. There also exist two portable cameras (installed on the alignment windows of the vacuum vessel from outside) to monitor the state inside the vacuum vessel. One of them is a highly-sensitive type and the other is a normal type. There is no ITV camera installed inside the vacuum vessel. The entire images taken by the cameras can be recorded up to 30 days in time-division time lapse videos, allowing the required images to be copied on normal videos.

The jacks of the image/EP cables for the portable cameras are to be plugged in/out after making sure that the power is turned off.

(2) Communication system for operation

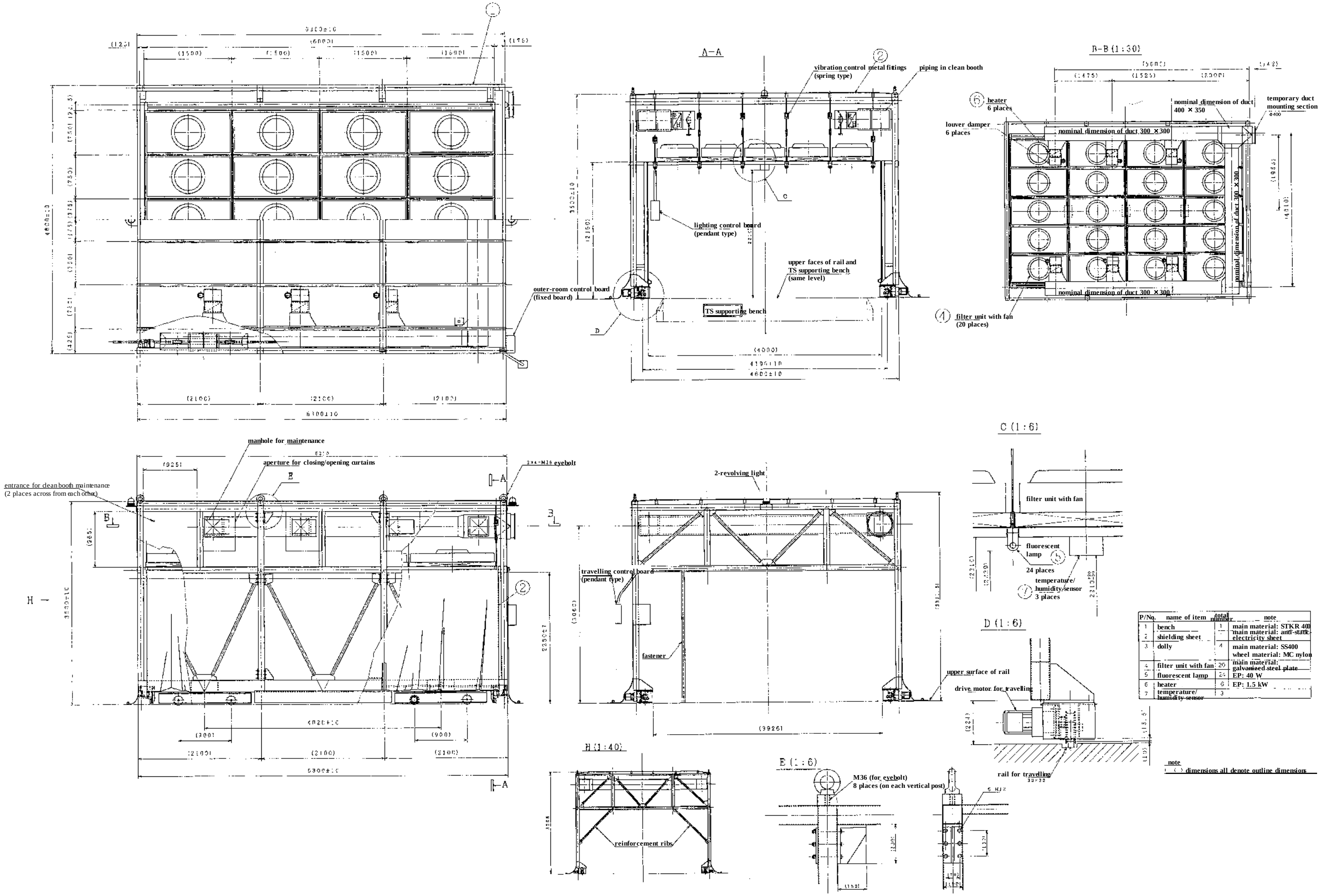
This system is made up of wired and wireless paging devices (multi-function telephones and cellular phones (digital)) which enable mutual communication among test-concerned personnel and announcement of instructions during the operation of the facility or preparation for testing on a TS.

(3) Clean booth

A clean booth is designed to achieve and maintain a highly clean environment for the preparation and execution of tests. Its basic specifications and external view are shown below and in Figure 2-13, respectively.

Table 2-10 Basic Specifications of Clean Booth

item	specification
performance, structure	cleanliness: ISO class 5 （equivalent of FED-STD-209 class 100)
	temperature: set temperature (20 ~ 23℃) ± 1℃
	humidity: 50 ± 10％
	dimensions: 6m (width) × 4.6m (depth) × 3.5m (height)
	mass: 3,000 kg
location	inside the preparation room or vacuum vessel
installation environment	
(inside vacuum vessel, preparation room)	cleanliness: ISO class 7 (equivalent of FED-STD-209 class 10,000)
	temperature: 23 ± 3℃
	humidity: 50 ± 10％



P/No.	name of item	total number	note
1	bench	1	main material: STKR 400
2	shielding sheet		main material: anti-static-electricity sheet
3	dolly	4	main material: SS400 wheel material: MC nylon
4	filter unit with fan	20	main material: galvanized steel plate
5	fluorescent lamp	24	EP: 40 W
6	heater	6	EP: 1.5 kW
7	temperature/ humidity sensor	3	

Figure 2-13 Clean Booth

2.2.9. Gadgets and Spares

(1) Mass-filter-type mass spectrometer (QMG220M3): 1 set

This device measures and analyzes the remnant gas components inside the vacuum vessel with its quadrupole analyzer.

Mass measurement range: M/e = 1 ~ 300

(2) Calorimeter (cf. Figures 2-14, 15): 30 sets

A calorimeter measures the radiant energy irradiated on a satellite from external heat sources, e. g., an IR lamp, for the purposes of setting, monitoring, and controlling test conditions for each test on a satellite, etc.

Measurement range: 0.1 kW/m^2 ~ 2.0 kW/m^2

Compatible thermocouple: copper-constantan

(3) TQCM (Thermoelectric Quartz Crystal Microbalance): 4 sets

(a) TQCM

Application purpose: for monitoring contamination

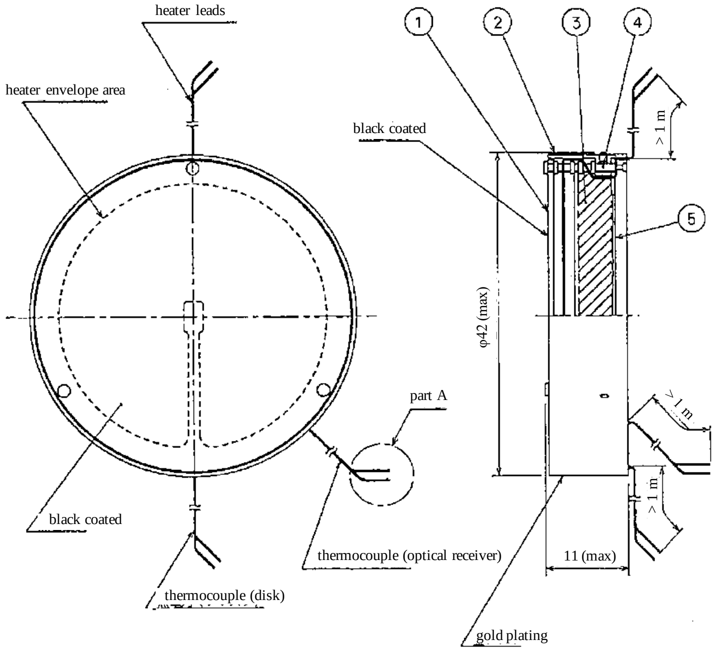
Model #: MK10 sensor, MODEL 1900 processor, MODEL 1800 temperature controller, manufactured by QCM Research Corp.

(b) TQCM mounting table

Mounting part: hard points on the TS supporting bench

Note) Cautions for mounting TQCM sensors

- The temperature of a TQCM sensor may not go down if it is surrounded by heat sources, e. g., IR panels, due to the thermal input from them. In that case, measures are to be taken by mounting the sensor after its heat sink surface is cooled down, for example.
- When using TQCM with its HEAT PUMP (Peltier device) turned on, use it at – 110℃ or higher.



specification

- measurement range: 0.1~2.0 kW/m2
- view angle: hemisphere
- reproducibility: within ±0.5% (note 1)
- accuracy: within ±0.3% (note 1)
- response time: within 10 sec (note 2)
- output level: -5 ~ + 7 mV
- weight: 10 g or less (note 4)
- applied thermocouple: copper-constantan
- solar absorptivity: 0.96 ±0.0.2 (note 6)
- hemisphere IR emissivity: 0.88 ±0.04 (note 6)

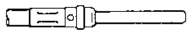
note

1. It denotes the tolerance to the full scale in measurement range.
2. It denotes the time to take for temperature on the optical receiver to change by 10 ℃ when 1 solar is radiated on it with the initial temperature of -180℃~-100℃.
3. Size tolerance shown below is to be followed when not specified.

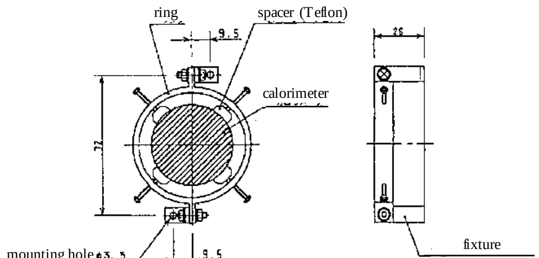
classification by nominal size	tolerance
~ 6	±0.6
over 6 ~ 18	±1
over 18 ~ 50	±1.3
over 50 ~ 120	±2
over 120 ~ 250	±2.5
over 250 ~ 500	±3.2
over 500 ~ 1000	±5
over 1000 ~ 2000	±8
over 2000 ~ 3150	±10

4. Heater leads, thermocouple wires, contact pins, and standard supports are excluded.
5. Heater leads and thermocouple wires are to have a 0.1-mm-φ central line and 1-m length or more.
6. The measurement values are based on the sample coating.

	name	material	quantity
1	optical receiver	alumina	1
2	case	Al	1
3	insulation	Al Mylar	1
4	support	polyimide resin	3
5	disc	Al	1



enlarged view of part A
(appearance of contact pin)
non scale



standard support

manufactured by 0603-34-2039 (Cu)
Japan Deutsches co. 105372 (Co)

Figure 2-14 Calorimeter

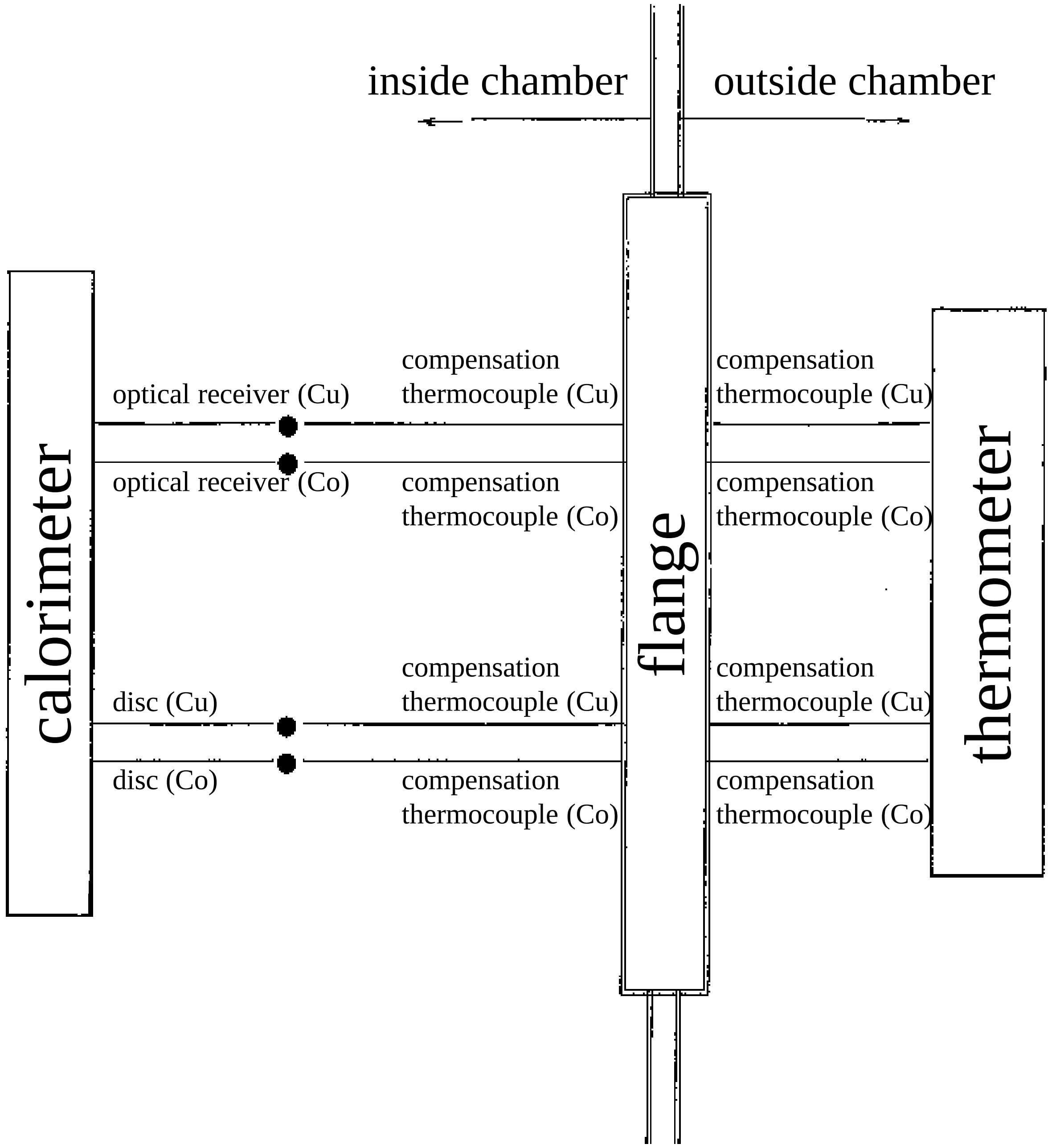


Figure 2-15 WBD Example of Calorimeter to Power Supply for Heat Sources

3. User I/F

3.1. Configuration between Inside and Outside of Space Chamber

A system diagram of the post-TS-installation state of this facility is shown in Figure 3-1.

3.2. Measurement and Control Room

The measurement and control room (1F) possesses controllers and monitors for each of the control and monitor system and the data acquisition system.

The measured TS temperature, etc., can be checked in the data acquisition system, and the operation of the setting monitoring computer, T-QCM console, vibration analyzer, clean booth operation console, and the power supplies for heat sources is to be executed by users. If a TS is to be partially cooled or heated (cf. section 3.3.1.5), inform the company in charge of the facility of the automatic valve aperture percentage.

Figure 3-2 shows the configuration of the devices in the measurement and control room.

3.3. Device I/Fs

3.3.1. Vacuum Vessel

3.3.1.1. Nozzle Configuration in Vacuum Vessel

There are nozzles with flanges all over the vacuum vessel as the I/Fs to connect the inside and outside of the vessel (cf. Figure 3-3.) The nozzles not being used by the facility are available to users.

Especially, the main chamber body (to the measurement and control room side) has flanges for a TS with specific purposes as signals, EP, thermocouples, waveguides, etc.

In case feed-through terminals other than the ones prepared by the facility are necessary, users are to prepare the flanges with feed-through terminals to satisfy their designated purposes. A table of flanges is shown in Table 3-1.

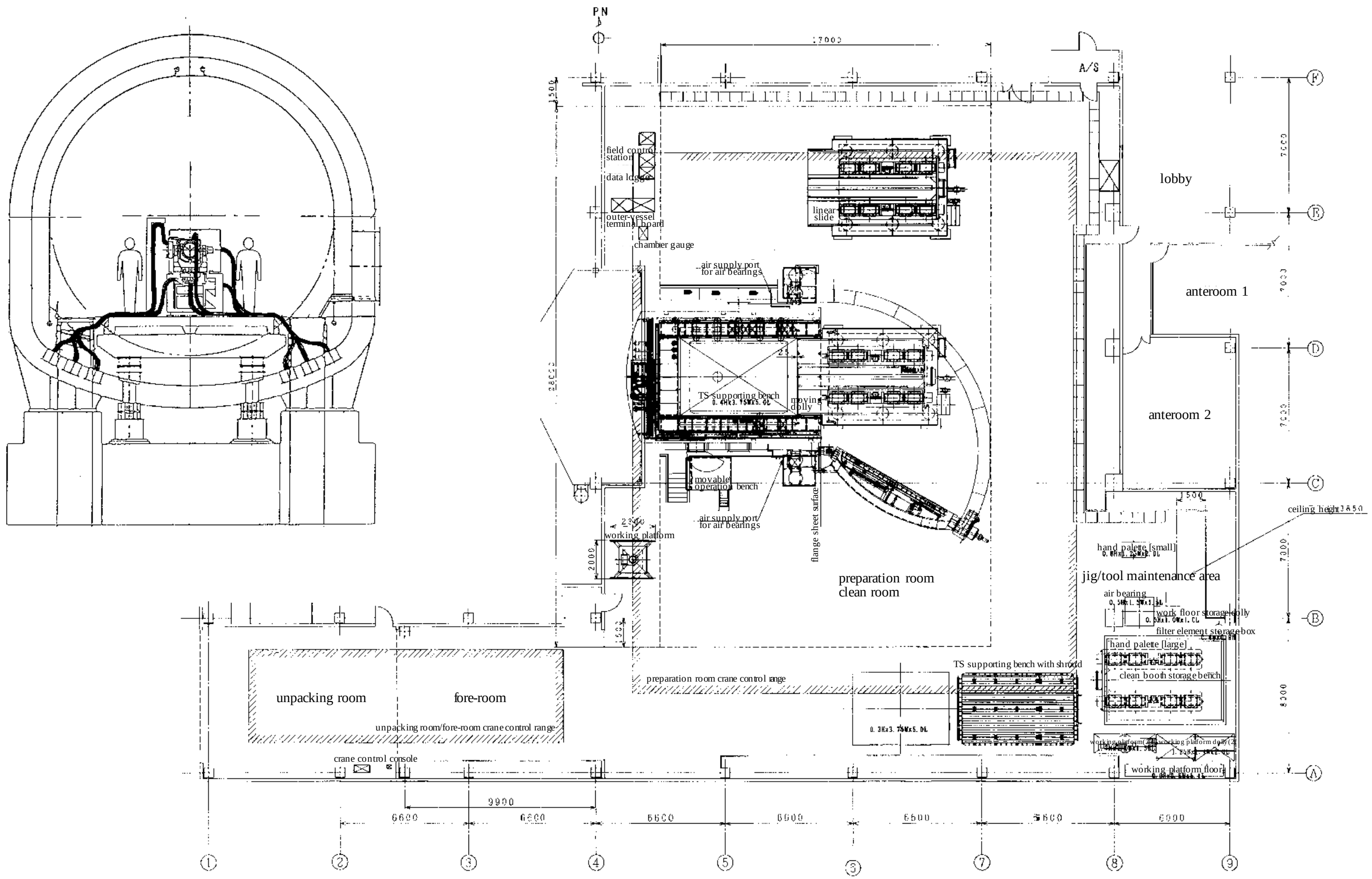
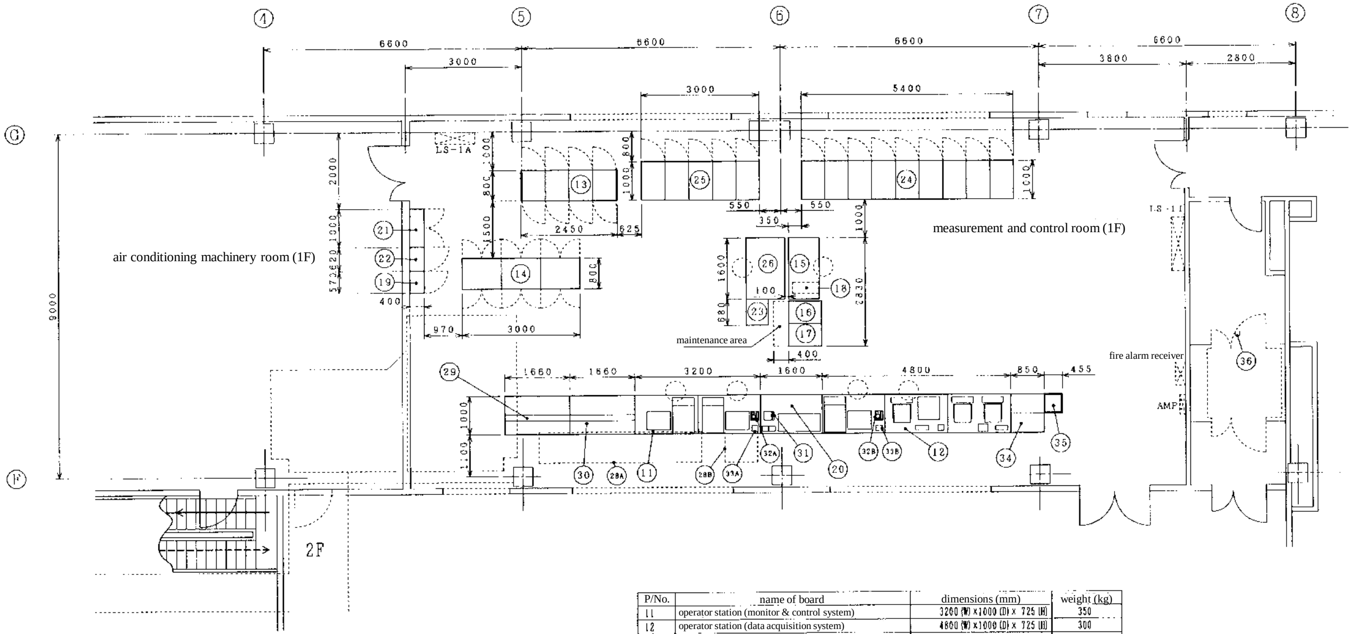
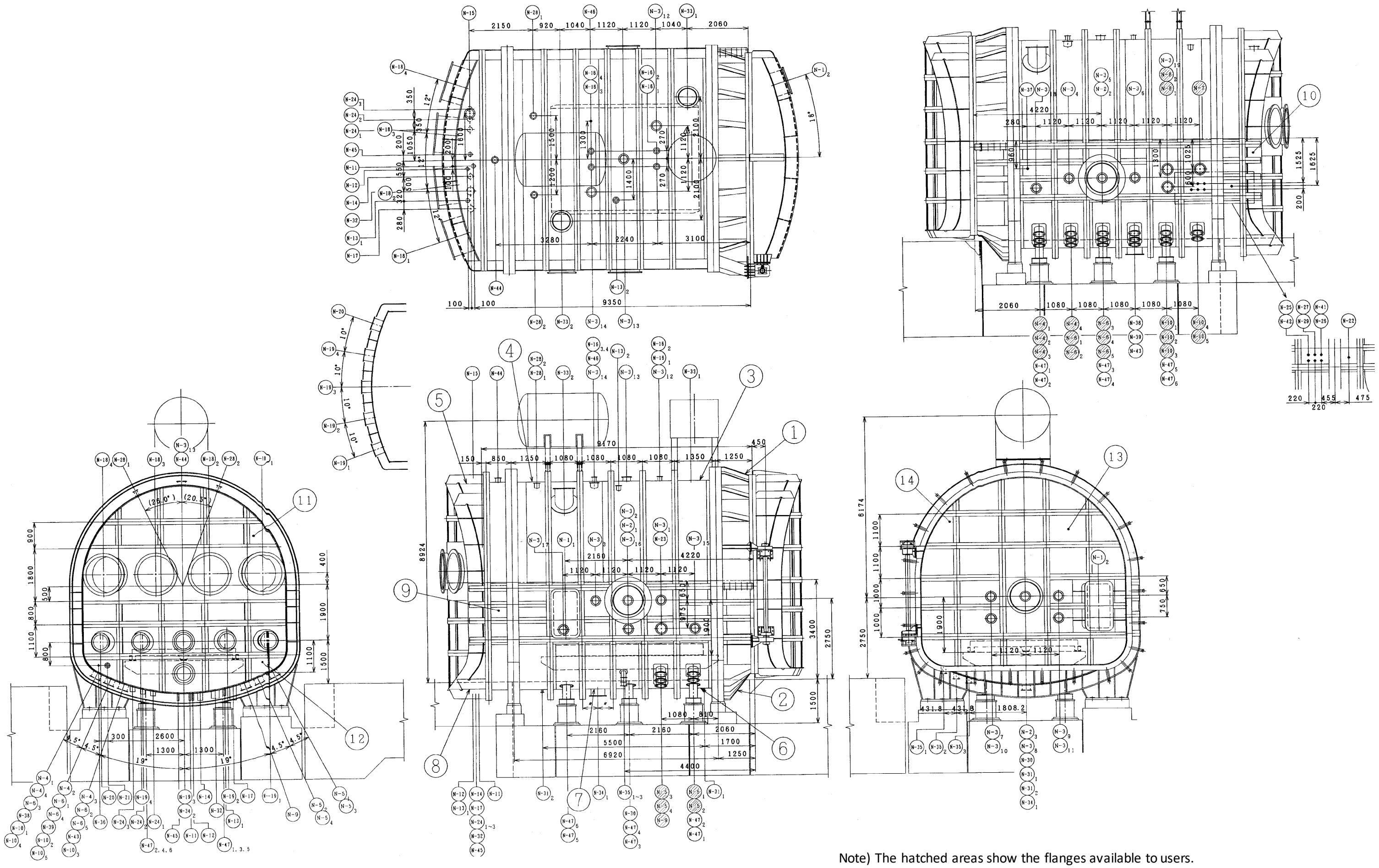


Figure 3-1 System Diagram for Operation in Preparation Room



P/No.	name of board	dimensions (mm)	weight (kg)
11	operator station (monitor & control system)	3200 (W) ×1000 (D) × 725 (H)	350
12	operator station (data acquisition system)	4800 (W) ×1000 (D) × 725 (H)	300
13	field control station (monitor & control system)	2450 (W) × 800 (D) ×2105 (H)	1400
14	inter lock & emergency stop board (monitor & control system)	3000 (W) × 800 (D) ×1950 (H)	1200
15	vibration analyzer (vibration isolation system) [color display, console, printer]	1600 (W) × 800 (D) × 700 (H)	
16	vibration analyzer (vibration isolation system) [signal conditioner]	590 (W) × 854 (D) ×1312 (H)	
17	vibration analyzer (vibration isolation system) [signal conditioner]	590 (W) × 854 (D) ×1312 (H)	
18	vibration analyzer (vibration isolation system) [uninterruptible power supply]	280 (W) × 560 (D) × 550 (H)	
19	communication device (cabled)	570 (W) × 432 (D) ×2300 (H)	250
20	ITV device	1600 (W) ×1000 (D) × 725 (H)	
21	control power supply distribution board	1000 (W) × 400 (D) ×1950 (H)	250
22	communication device (radio)	620 (W) × 432 (D) ×2300 (H)	250
23	remnant gas analyzer (MSQ data acquisition system)	680 (W) × 570 (D) ×1600 (H)	
24	IR power supply system (for high power)	5400 (W) ×1000 (D) ×2000 (H)	4050
25	IR power supply system (for low power)	3000 (W) ×1000 (D) ×2000 (H)	2500
26	MO disc file system (1) (main system)	1600 (W) ×1000 (D) × 725 (H)	
27	(missing number)		
28A	ITV system monitor	(shelf) 4140 (W) × 800 (D) × 600 (H)	240
28B	ITV system monitor	(shelf) 840 (W) × 800 (D) × 600 (H)	40
29	clean booth control console	1660 (W) ×1000 (D) ×1200 (H)	150
30	emergency stop operation console	1660 (W) ×1000 (D) ×1200 (H)	300
31	handset		
32A, B	telephone		
33A, B	desktop monitor, speaker		
34	TQCM operation console	850 (W) ×1000 (D) ×1050 (H)	150
35	time & vacuum level display (17 inch monitor)	405 (W) × 450 (D) × 420 (H)	
36	oxygen level warning revolving light in vacuum vessel lower part pit		

Figure 3-2 Configuration of Devices in Measurement and Control Room



Note) The hatched areas show the flanges available to users.

Figure 3-3 Configuration of Feed-through Terminal Nozzles

Table 3-1 Table of Flanges (1/2)

sign	nominal φ	qty	model #	name	note
N-1	1500 × 800	2	SPECIAL	man door	straight cylindrical body 1, access door 1
N-2	1000φ	3	SPECIAL	optical window	straight cylindrical body 2, access door 1
N-3	250A	19	JIS VG	alignment window	straight cylindrical body 11, upper part 3, access door 5
N-4	300A	4	JIS VG	for CC thermocouples (incl. calorimeters, spares)	for TS thermocouples
N-5	300A	4	JIS VG	current inlet terminal	for IR power supplies ($N\text{-}5_4$ is for spare)
N-6	300A	5	JIS VG	current inlet terminal (100V, 5A)	for TS signals
N-7	300A	1	JIS VG	high frequency output signal (coaxial)	
N-8	300A	2	JIS VG	for waveguides	only nozzles; $N\text{-}8_1$ can also be used for the alignment window.
N-9	300A	1	JIS VG	current inlet terminal (200V, 10A)	for TS EP
N-10	300A	5	JIS VG	spare nozzle	
N-11	150A	1	stub end	LN_2 piping	IR gauge
N-12	125A	1	stub end	LN_2 piping	
N-13	150A	2	stub end	LN_2 piping	
N-14	200A	1	stub end	LN_2 piping	
N-15	250A	1	stub end	LN_2 piping	
N-16	150A	4	stub end	LN_2 piping	
N-17	250A	1	stub end	He piping	
N-18	1250A	4	SPECIAL	cryosorption pump	
N-19	500A	4	JIS VG	turbo molecular pump	
N-20	500A	1	JIS VG	low vacuum system, vacuuming port	
N-21	100A	1	JIS VG	dry air inlet port	
N-22	32A	1	ICF 70	residual gas analyzer pipe port	
N-23	300A	1	JIS VG	current inlet terminal	for vibration analysis
N-24	150A	3	JIS VG	GN_2 entrance	
N-25	20A	1	JIS VG	Bourdon tube pressure gauge	
N-26	32A	1	ICF 70	Pirani gauge	
N-27	32A	1	ICF 70	BA gauge	
N-28	100A	2	JIS VG	ionization gauge (nude gauge)	
N-29	32A	1	ICF 70	ionization gauge (wide range A)	
N-30	250A	1	JIS VG	GN_2 exit	

Table 3-1 Table of Flanges (2/2)

N-31	50A	2	JIS VG	for scavenger cryopanel drains	
N-32	300A	1	stub end	for partial cooling of TS	IR gauge
N-33	600A	2	JIS VG	for permanently equipped lighting	
N-34	500A	2	JIS VG	manhole (for operation)	on the chamber head 1, on the bottom of the body: 1
N-35	150A	3	JIS VG	GN_2 exit	
N-36	15A	1	―	GN_2 entrance	
N-37	32A	1	ICF 70	for safety switches	
N-38	300A	1	JIS VG	for facility, shroud temperature measurement	
N-39	300A	1	JIS VG	for facility, SBG temperature (incl. T-QCM)	
N-40	150A	1	JIS VG	safety device	attached to the vacuuming port piping of low vacuum system
N-41	32A	1	ICF 70	ionization gauge (wide range B)	
N-42	20A	1	JIS VG	diaphragm pressure gauge	
N-43	300A	1	JIS VG	current inlet terminal	for resistor temperature measurement
N-44	200A	1	stub end	LN_2 piping	
N-45	150A	1	stub end	LN_2 piping	
N-46	20A	1	JIS VG	oximeter	
N-47	450A	6	JIS VG	nozzle for optical bench post	

Note) The shaded lines denote the flanges available to users.

3.3.1.2. WBD for EP, Signals, etc.

Refer to the following Figures and Tables for the cabling or the connector WBD between a TS and its check-out devices, etc., inside and outside the chamber, and choose the appropriate items according to the purposes.

(1) Table of Feed-through Terminals for Current/Thermocouples (for users) (Table 3-2)

(2) WBD Diagram of Feed-through Terminal (Figure 3-4)

(3) WBD Diagram of Signal Lines (5A) for TS [plug signs A1 ~ 100] (Figure 3-5)

(4) WBD Diagram EP Lines (10A) for TS [plug signs B1 ~ 11] (Figure 3-6)

(5) WBD Diagram of Thermocouples/Calorimeters for TS, and Thermocouple Spare Lines [plug signs C1 ~ 42, D1 ~ 5, N1 ~ 2] (Figure 3-7)

(6) WBD Diagram Temperature Sensors (thermistor platinum sensors) for TS [plug signs E1 ~ 13] (Figure 3-8)

(7) WBD Diagram of SBG Temperature Measurement [plug sings G1 ~ 3] (Figure 3-9)

(8) WBD Diagram of 2 kW IR Power Supply Rack (100V, 30A) [plug signs H1 ~ 15] (Figure 3-10)

(9) WBD Diagram of 60W IR Power Supply Rack (100V, 3A) [plug signs J1 ~ 6] (Figure 3-11)

(10) Feed-through Terminal for Coaxial Cables of TS (Figure 3-12)

(11) Inner-vessel Permanent Terminal Boards – I, II, III (Figure 3-13)

(12) External Input Terminal Boards – I, II (Figure 3-14)

Note) For grounding, the same type of plug as shown in (8) is to be used, which is connected to Q1 on the inner-vessel permanent terminal board (3); the pins A and B on Q1 respectively correspond to E3 and SE3 for grounding.

[Notes for Wiring Thermocouples]

The thermocouple terminal receptacles on the inner-vessel permanent terminal boards (Figure 3-13) are manufactured by Japan Deutsches co. while those on the external input terminal boards (Figure 3-14) are manufactured by Hitachi Power Semiconductor Device, Ltd. The two companies’ receptacles have different numbers of conductors and pin configurations, which requires attention to the following matters.

(1) The terminal pair on the Japan Deutsches’ connector that corresponds to the J-Q pair on the Hitachi Power Semiconductor Device’s connector is J-Ċ, due to the lack of terminal Q.

(2) The terminals a and b on the Japan Deutsches’ connector are to be left unused.

(3) Since the K-R and J-Ċ pin pairs on the Japan Deutsches’ connector are located away from each other, the order of WBD is to be determined with that fact taken into account.

(4) The thermocouple plugs do not include socket contacts, which are therefore to be procured based on the specifications shown below.

- Manufactured by Japan Deutsches co.
  - Socket contact (Cu) : model # 0603-34-2039
  - Socket contact (constantan) : model # 105372
- Manufactured by Hitachi Power Semiconductor Device, Ltd.
  - Socket contact (Cu) : Figure 3-15 NM-104-845-article # 1
  - Socket contact (constantan) : Figure 3-15 NM-104-845-article # 2

sign	application purpose	specification	connector #	usable times	situation	Figure
A	signal line	100V/5A	A1～A100	499	A29 : not available wired from inside chamber ～ external input terminal board	3-5
B	EP	100V/10A	B1～B11	44	wired from inside chamber ～ external input terminal board	3-6
C	thermocouple	CC	C1～C42	479	C3 : ch 2～12 not available C14 : ch 12 not available C28 : ch 12 not available C42 : all 12chs not available	3-7
D	calorimeter	CC	D1～D5	60		
N	thermocouple spare	CC	N2	11	N2 : ch 12 not available	
E	thermometric resistor thermistor, platinum sensor	–	E1～E13	30	via converter board LP910 to data acquisition system (logger)	3-8
H	EP	100V/30A	H1～H15	30	H1～H5 : connected to 2kW power supply rack-1 H6～H10 : connected to 3kW power supply rack H11～H15 : 2kW power supply rack-2 (power supplies No.3 4 are not available.) H12 : for facility supporting bench heater	3-10
J	EP	100V/3A	J1～J6	30	J1～J5 : connected to 60W power supply J6 is wired from inside chamber ～ external input terminal board	3-11

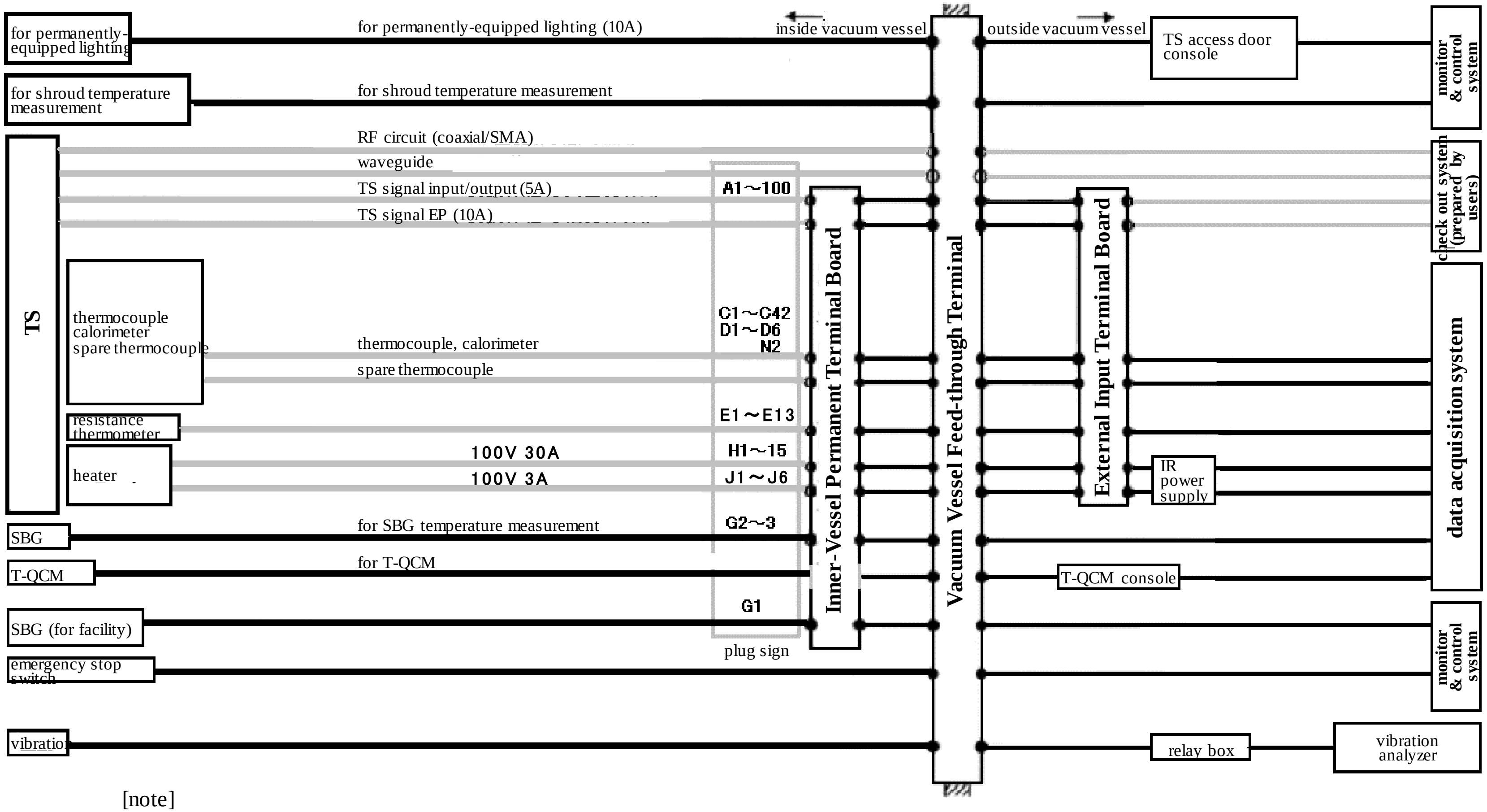
to be prepared by users

item #	application purpose	specification: current	specification: voltage	qty of circuits	Min. necessary qty of conductors	qty of shells per 1 flange	nozzle allocation: size	nozzle allocation: sign	notes	inner-vessel permanent terminal board: dust cap	inner-vessel permanent terminal board: plug	inner-vessel permanent terminal board: receptacle	inner-vessel permanent terminal board: junction shell	inner-vessel permanent terminal board: cable clamp
1	TS signals (5A)	5A	DC 100V	500	1000 (1000)	10 ×20 conductors	300AX5	N-6 1～5	#16×10 conductors	MS25043-18D 100	MS3106B18-1S 100	MS3102A18-1P 100	CA2120-9 100	MS3057-10A 100
	connector maker	–	–	–	–	–	–	–	–	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited
2	TS EP (10A)	10A	DC 100V	40	80 (88)	8 ×11 conductors	300AX1	N-9	#12×8 conductors	MS25043-22D 11	MS3106B22-23S 11	MS3102A22-23P 11	CA2120-11 11	MS3057-12A 11
	connector maker	–	–	–	–	–	–	–	–	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited
3	TS thermocouple	C. C.		500	1000 (1008)	24 ×14 conductors	300AX3	N-4 1～3	#16×24 conductors	660-009M16S6-04 42	[※2] AFD55-16-28SN-043 42	AFD50-16-26PN-1A 42	–	94003-16-3014 42
	connector maker	–		–	–	–	–	–	–	Japan Deutsches co.	Japan Deutsches co.	Japan Deutsches co.	–	Japan Deutsches co.
4	calorimeter (60 ch) spare thermocouple (20 ch)	C. C.		60 20	120 40 (168)	24 ×5 24 ×2 (24 ×7)	300AX1	N-4 4	#16×24 conductors	660-009M16S6-04 7	[※2] AFD55-16-28SN-043 7	AFD50-16-26PN-1A 7	–	94003-16-3014 7
	connector maker	–		–	–	–	–	–	–	Japan Deutsches co.	Japan Deutsches co.	Japan Deutsches co.	–	Japan Deutsches co.
5	TS temperature measurement (thermistor, platinum sensor)	1A	DC 100V	30	120 (130)	10 ×13 conductors	300AX1	N-43	#16×10 conductors	MS25043-18D 13	MS3106B18-1S 13	MS3102A18-1P 13	CA2120-9 13	MS3057-10A 13
	connector maker	–	–	–	–	–	–	–	–	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited
6	shroud temperature measurement	C. C.		30	60 (72)	24 × 3 conductors	300AX1	N-38	#16×24 conductors	–	–	–	–	–
	connector maker	–		–	–	–	–	–	–	–	–	–	–	–
7	SBG temperature measurement [※1] TQCM	1A	DC 100V	5 12	20 48 (110)	10 ×3 10 ×8 10 ×11	300AX1	N-39	#16×10 conductors	MS25043-18D 3	MS3106B18-1S 3	MS3102A18-1P 3	CA2120-9 3	MS3057-10A 3
	connector maker	–	–	–	–	–	–	–	–	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited
8	IR power supply (100V 30A) TS grounding	30A	DC 100V	25 (2)	50 4 (64)	4 ×15 4 ×1 (4 ×16)	300AX2	N-5 1, 2	#4×4 conductors	MS25043-32D 16	MS3106B32-17S 16	MS3102A32-17P 16	CA2120-14 16	MS3057-20A 16
	connector maker	–	–	–	–	–	–	–	–	Japan Aviation Electronics Industry, Limited	DDK Ltd.	DDK. Ltd.	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited
9	IR power supply (100V 3A)	3A	DC 100V	25	50 (60)	10 ×6 conductors	300AX1	N-5 3	#16×10 conductors	MS25043-18D 6	MS3106B18-1S 6	MS3102A18-1P 6	CA2120-9 6	MS3057-10A 6
	connector maker	–	–	–	–	–	–	–	–	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited
10	RF coaxial (SMA)	SMA		20	20	20	300AX1	N-7	–	–	–	–	–	–
	connector maker	–		–	–	–	–	–	–	–	–	–	–	–
11	permanently-equipped lighting	10A	DC 100V	2	4	4 ×1 conductors	1CF70X2	N-33 1, 2	#16×4 conductors	–	–	–	–	–
	connector maker	–	–	–	–	–	–	–	–	–	–	–	–	–
12	all system emergency abort SW	1A	DC 100V	1	2 (4)	4 ×1 conductors	1CF70X1	N-37	#16×4 conductors	–	MS3106B14S-2S 1	MS3102A14S-2P 1	CA2120-4 1	MS3057-6A 1
	connector maker	–	–	–	–	–	–	–	–	–	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited
13	TS thermocouple relay	C. C.		–	120	24 ×5 conductors	–	–	#16×24 conductors	–	–	–	–	–
	connector maker	–	–	–	–	–	–	–	–	–	–	–	–	–

item #	application purpose	vacuum vessel feed-through terminal: cable clamp	vacuum vessel feed-through terminal: plug	vacuum vessel feed-through terminal: plug	vacuum vessel feed-through terminal: cable clamp	preparation room external input terminal board: cable clamp	preparation room external input terminal board: junction shell	preparation room external input terminal board: receptacle	preparation room external input terminal board: plug	note: terminal #
1	TS signals (5A)	MS3057-10A 100	MS3106B18-1S 100	MS3106B18-1S 100	MS3057-10A 100	MS3057-10A 100	CA2120-9 100	MS3102A18-1P 100	MS3106B18-1S 100	A1～A100
	connector maker	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	–
2	TS EP (10A)	MS3057-12A 11	MS3106B22-23S 11	MS3106B22-23S 11	MS3057-12A 11	MS3057-12A 11	CA2120-11 11	MS3102A22-23P 11	MS3106B22-23S 11	B1～B11
	connector maker	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	–
3	TS thermocouple	MS3057-16A 42	JA3106B24-J28SC 42	JA3106B24-J28SC 42	MS3057-16A 42	MS3057-16A 84 (42)	CA2120-12 42	JA3102A24-J28PC 42	JA3106B24-J28SC 42	C1～C42
	connector maker	Japan Aviation Electronics Industry, Limited	Hitachi Power Semiconductor Device, Ltd.	Hitachi Power Semiconductor Device, Ltd.	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Hitachi Power Semiconductor Device, Ltd.	Hitachi Power Semiconductor Device, Ltd.	–
4	calorimeter (60 ch) spare thermocouple (20 ch)	MS3057-16A 7	JA3106B24-J28SC 7	JA3106B24-J28SC 7	MS3057-16A 7	MS3057-16A 14 (7)	CA2120-12 7	JA3102A24-J28PC 7	JA3106B24-J28SC 7	D1～D5 N1, N2
	connector maker	Japan Aviation Electronics Industry, Limited	Hitachi Power Semiconductor Device, Ltd.	Hitachi Power Semiconductor Device, Ltd.	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Hitachi Power Semiconductor Device, Ltd.	Hitachi Power Semiconductor Device, Ltd.	–
5	TS temperature measurement (thermistor, platinum sensor)	MS3057-10A 13	MS3106B18-1S 13	MS3106B18-1S 13	MS3057-10A 13	MS3057-10A 26 (13)	CA2120-9 13	MS3102A18-1P 13	MS3106B18-1S 13	E1～E13
	connector maker	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	–
6	shroud temperature measurement	MS3057-16A 3	JA3106B24-J28SC 3	JA3106B24-J28SC 3	MS3057-16A 3	–	–	–	–	F1～F3
	connector maker	Japan Aviation Electronics Industry, Limited	Hitachi Power Semiconductor Device, Ltd.	Hitachi Power Semiconductor Device, Ltd.	Japan Aviation Electronics Industry, Limited	–	–	–	–	–
7	SBG temperature measurement [※1] TQCM	MS3057-10A 11	MS3106B18-1S 11	MS3106B18-1S 11	MS3057-10A 11	–	–	–	–	G1～G3 P1～P8
	connector maker	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	–	–	–	–	–
8	IR power supply (100V 30A) TS grounding	MS3057-20A 16	MS3106B32-17S 16	MS3106B32-17S 16	MS3057-20A 16	MS3057-20A 32 (16)	CA2120-14 16	MS3102A32-17P 16	MS3106B32-17S 16	H1～H15 Q1
	connector maker	Japan Aviation Electronics Industry, Limited	DDK Ltd.	DDK Ltd.	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	DDK Ltd.	DDK Ltd.	–
9	IR power supply (100V 3A)	MS3057-10A 6	MS3106B18-1S 6	MS3106B18-1S 6	MS3057-10A 6	MS3057-10A 12 (6)	CA2120-9 6	MS3102A18-1P 6	MS3106B18-1S 6	J1～J6
	connector maker	Japan Aviation Electronics Industry, Limited			Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	–
10	RF coaxial (SMA)	–	SMA 20	SMA 20	–	–	–	–	–	K1～K20
	connector maker	–	Huber + Suhner/ REPIC corporation	Huber + Suhner/ REPIC corporation	–	–	–	–	–	–
11	permanently-equipped lighting	MS3057-6A 2	MS3106B14S-2S 2	MS3106B14S-2S 2	MS3057-6A 2	–	–	–	–	L1, L2
	connector maker	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	–	–	–	–	–
12	all system emergency abort SW	MS3057-6A 1	MS3106B14S-2S 1	MS3106B14S-2S 1	MS3057-6A 1	–	–	–	–	M1
	connector maker	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	–	–	–	–	–
13	TS thermocouple relay	–	–	–	–	MS3057-16A 10	CA2120-12 5	JA3102A24-J28PC 5	JA3106B24-J28SC 5	–
	connector maker	–	–	–	–	Japan Aviation Electronics Industry, Limited	Japan Aviation Electronics Industry, Limited	Hitachi Power Semiconductor Device, Ltd.	Hitachi Power Semiconductor Device, Ltd.	–

Table 3-2 Table of Feed-through Terminals for Current/Thermocouples (1/2) (Simplified)

Table 3-2 Table of Feed-through Terminals for Current/Thermocouples (2/2) (Detailed)



[note]

① The cables represented by solid lines in the figure belong to the chamber as permanently equipped items.
② The inner-vessel permanent terminal boards, etc., have receptacles on them, to which plugs can be connected. The terminals indicated by ○ require both receptacles and plugs to be prepared by users (for those indicated by ●, users are to prepare plugs only.)
③ Waveguides including feed-through flanges are to be prepared by users for all the systems.
④ Special cables, e. g., for optical signals, Dsub connectors, etc., are to be prepared by users.
⑤ For coaxial cables, flanges with feed-through terminals are permanently equipped on the chamber.
⑥ The temperature of thermocouples is controlled by IR power supplies.

Figure 3-4 WBD Diagram of Feed-through Terminal

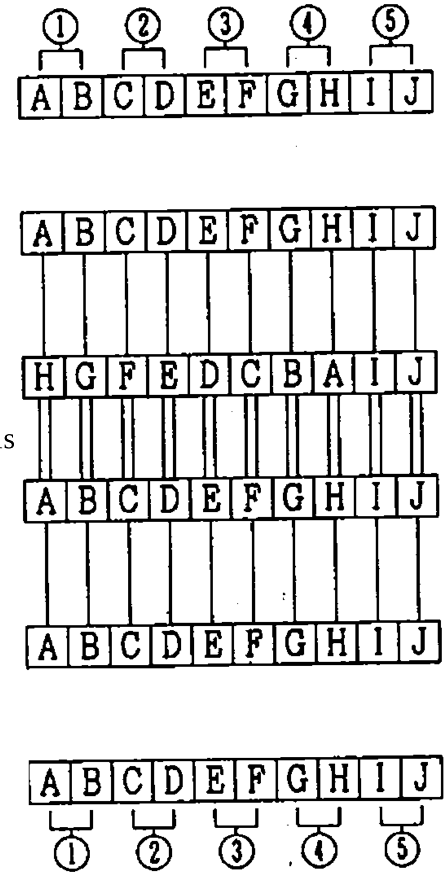
channel No.
plugs (manufactured by JAE)
model: MS3106B18-1S

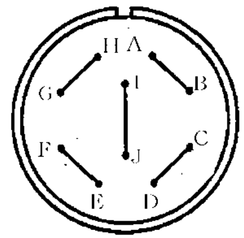
external input terminal
(manufactured by JAE)

vacuum vessel feed-through terminals

inner-vessel
permanent terminal board

plugs (manufactured by JAE)
model: MS3106B18-1S
channel No.

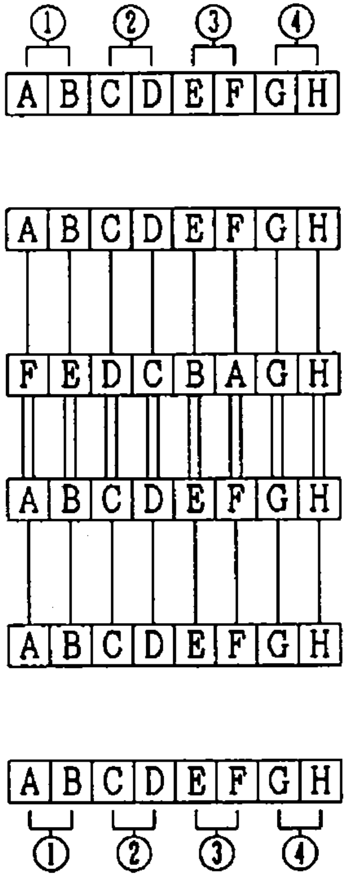


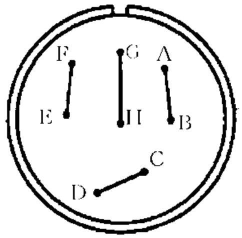


composition of contacts: #16 × 10
conductors

for TS signals
A1 ~ A100 (DC100V 5A)

Figure 3-5 WBD Diagram of Signal Lines for TS





composition of contacts: #12 × 8 conductors

for TS EP
B1 ~ B11 (DC100V 10A)

Figure 3-6 WBD Diagram of EP Lines for TS

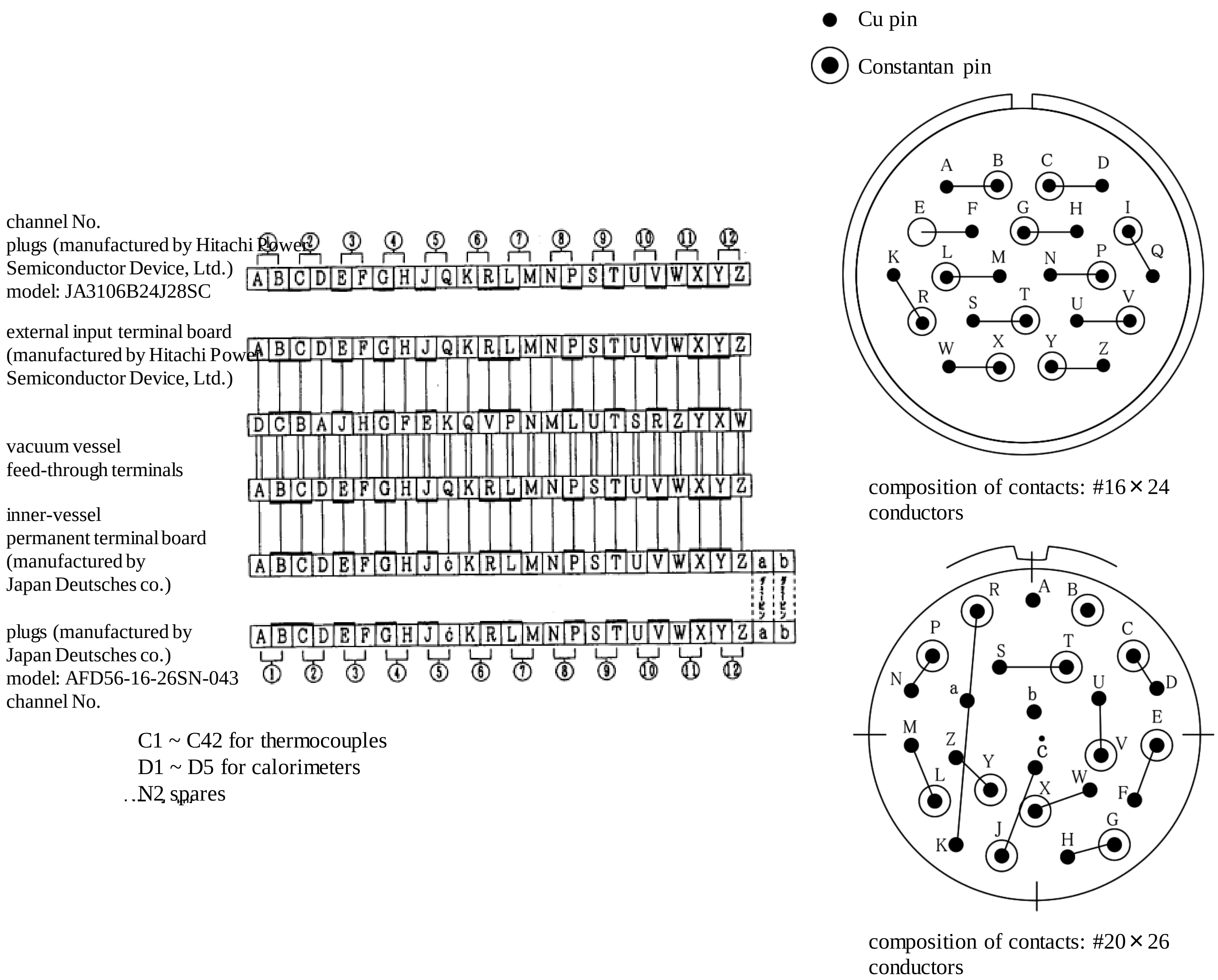
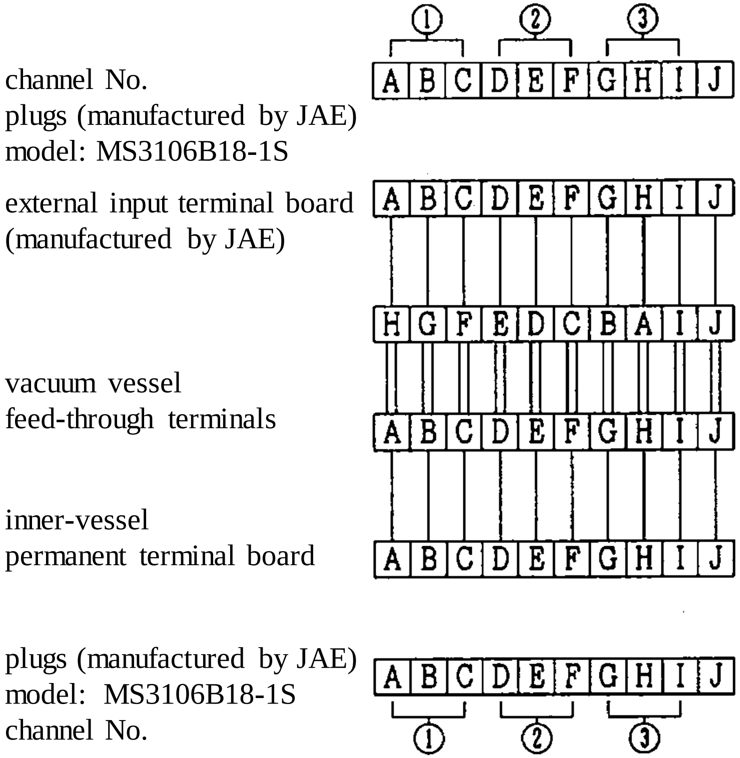
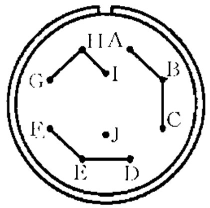


Figure 3-7 WBD Diagram of Thermocouples/Calorimeters for TS, and Thermocouple Spare Lines





composition of contacts: #16 × 10 conductors

for thermistors, platinum sensors
E1 ~ E13 (DC100V 1A)

Figure 3-8 WBD Diagram of Temperature Sensors for TS

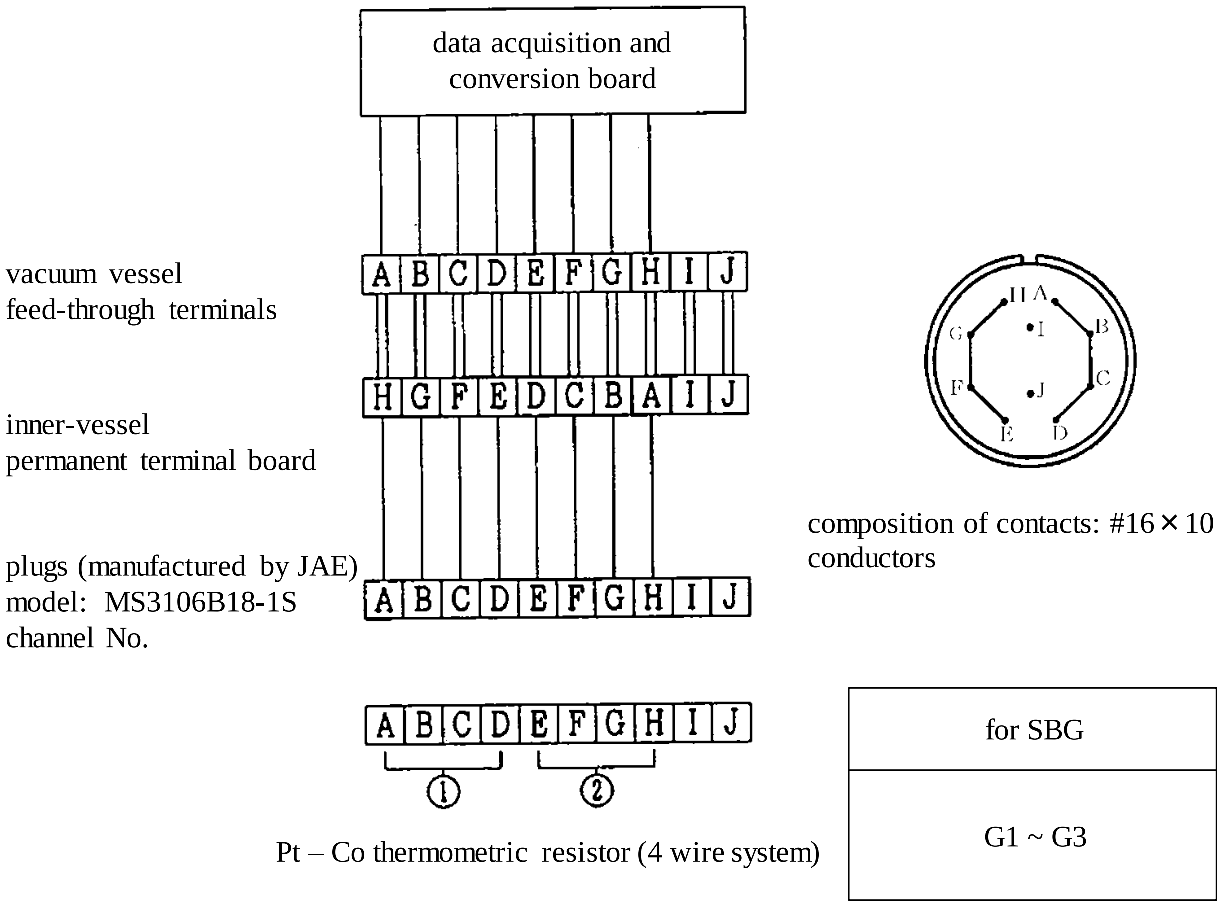
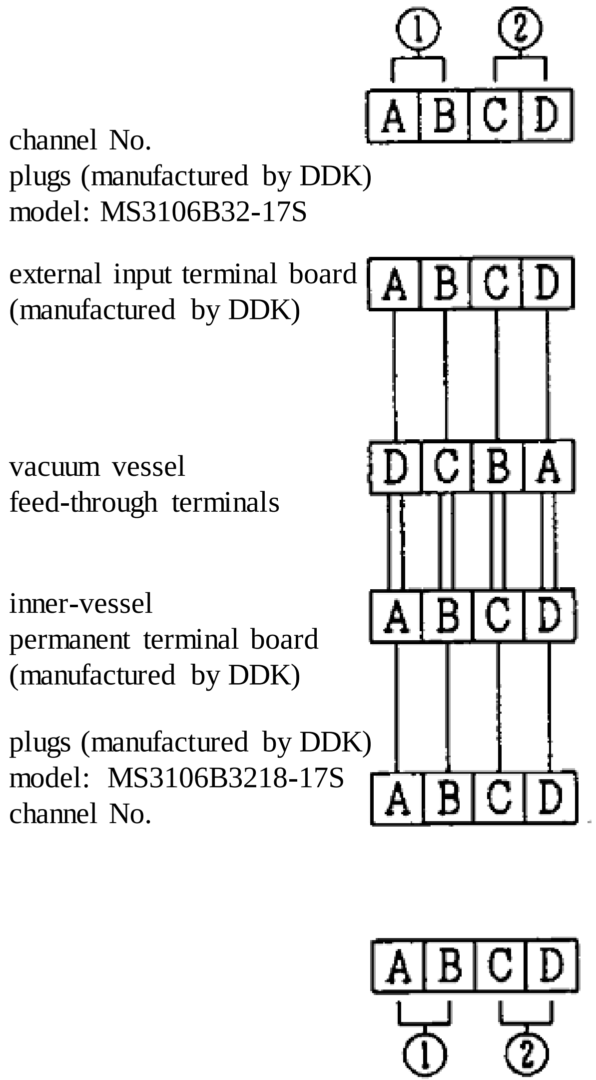
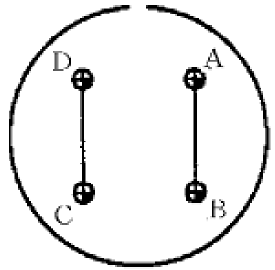


Figure 3-9 WBD Diagram of SBG Temperature Measurement

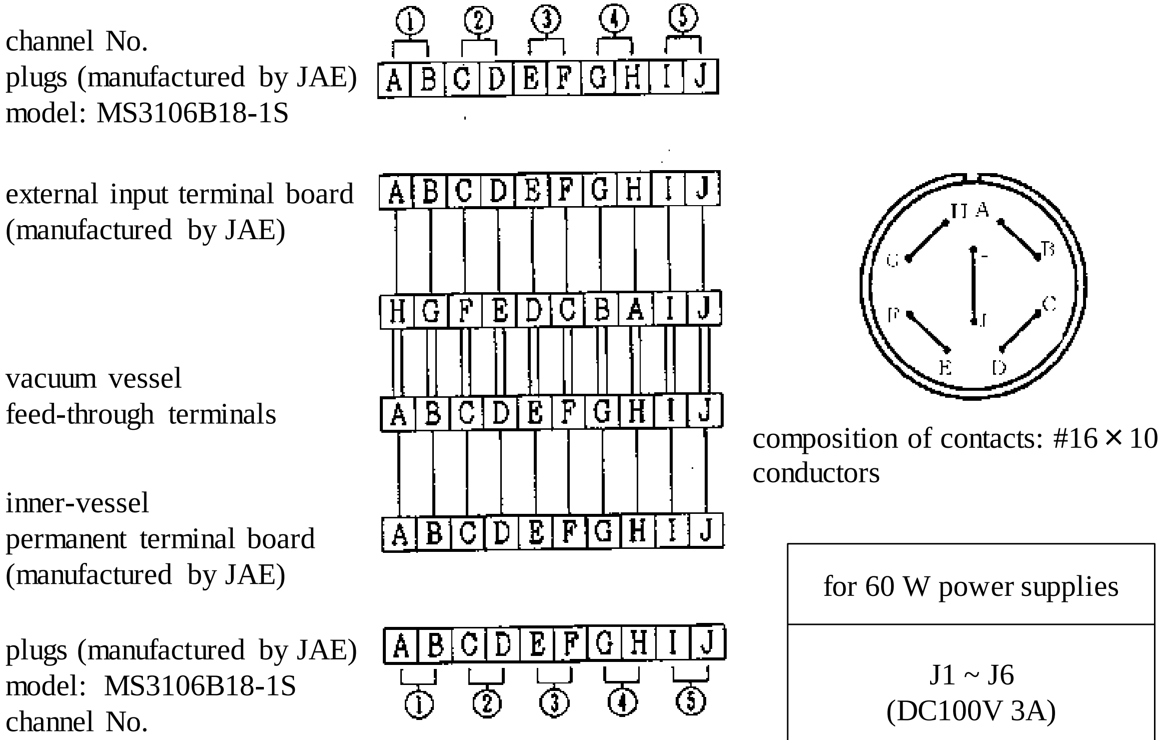




composition of contacts: #4 × 4 conductors

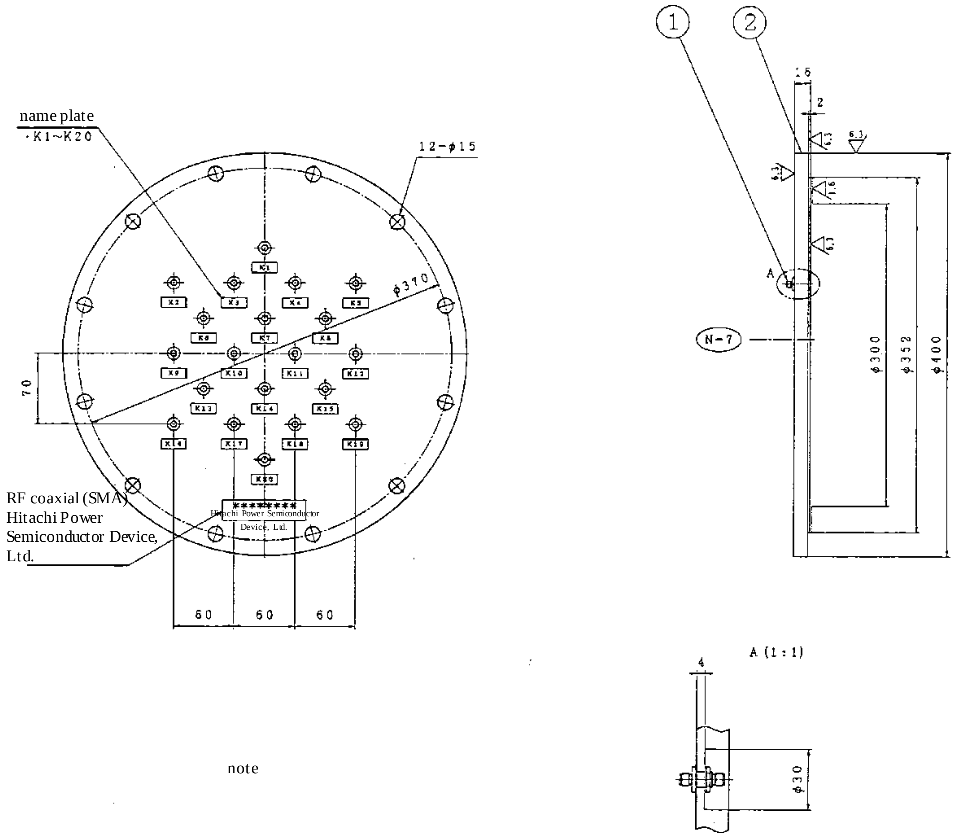
for 2 kW power supplies
H1 ~ H15 (DC100V 30A)

Figure 3-10 WBD Diagram of 2 kW IR Power Supply Rack



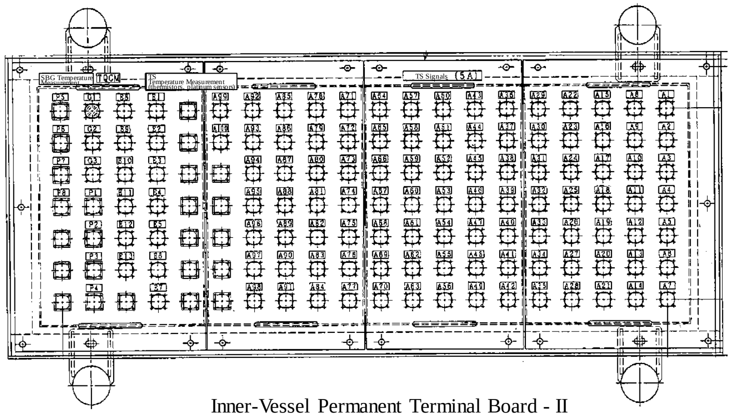
for 60 W power supplies
J1 ~ J6 (DC100V 3A)

Figure 3-11 WBD Diagram of 60W IR Power Supply Rack

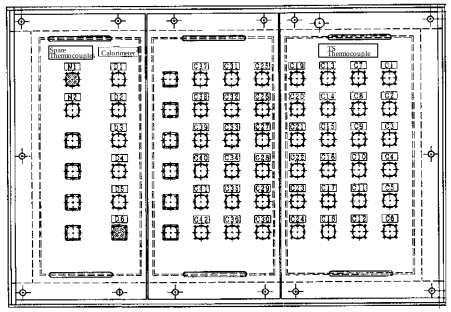


No.	name of parts	material	total number	note
①	hermetic seal	NL-005-931	20	
②	flange	SUS304	1	
③	plug (attachment)	–	40	Huber + Suhner 11SMA-50-3-14

Figure 3-12 Feed-through Terminal for Coaxial Cables of TS

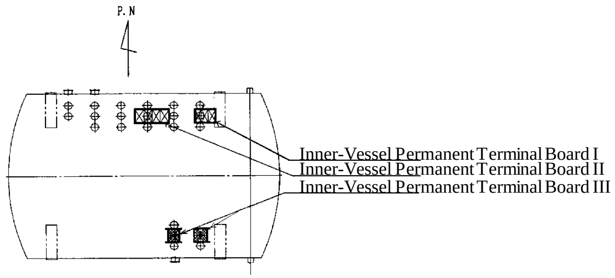


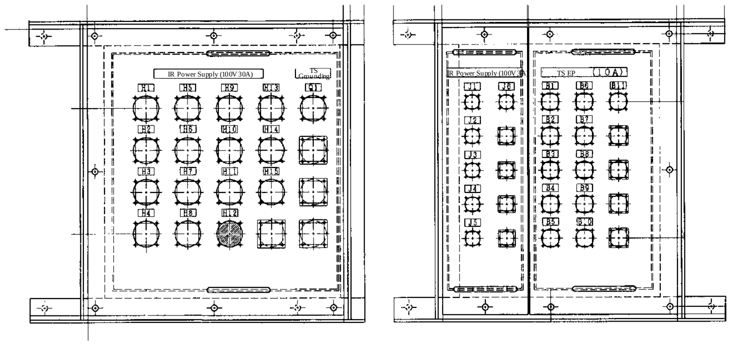
Inner-Vessel Permanent Terminal Board - II



Inner-Vessel Permanent Terminal Board - I

Mounting Positions of Permanent Terminal Boards



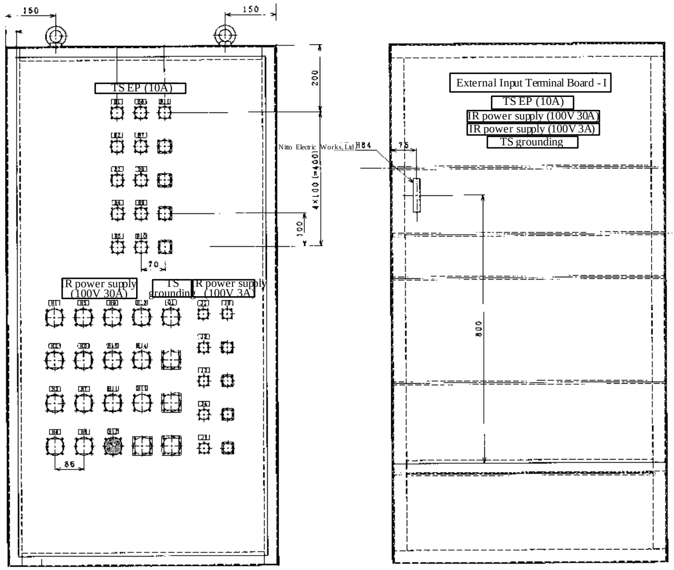


Inner-Vessel Permanent Terminal Board - III

Note1) The hatched parts are used by the facility.
Note2) The connection positions for shield earth are shown below.

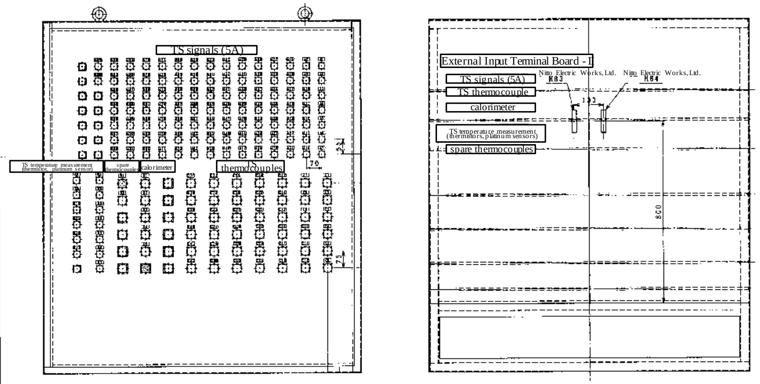
TS signal lines: J pins at E13 and G3
TS thermocouple lines: Z pins at C14, C28, C42
calorimeters and thermocouple spare lines: Z pin at N2

Figure 3-13 Inner-vessel Permanent Terminal Boards – I, II, III



External Input Terminal Board - I

Note) The hatched parts are used by the facility.



External Input Terminal Board - II

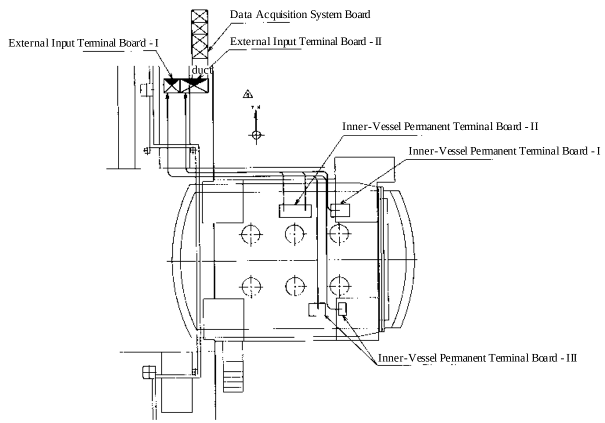
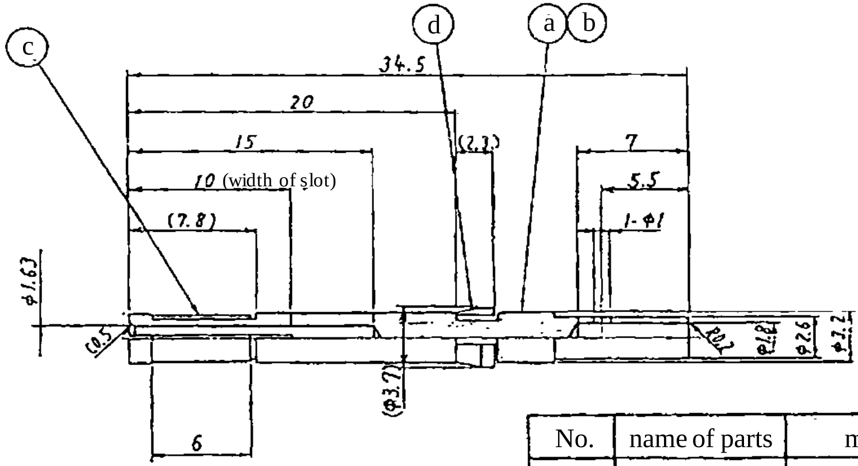


Figure 3-14 External Input Terminal Boards – I, II



No.	name of parts	material	total number	
			item #1	item #2
a	socket	copper (gold plating)	1	—
b	socket	constantan	—	1
c	spring	beryllium copper (gold plating)	1	1
d	ring	synthetic resins	1	1

Figure 3-15 Thermocouple Socket Contact (manufactured by Hitachi Power Semiconductor Device, Ltd.)

3.3.1.3. Details of Hard Ports

There are hard ports as shown in Table 3-3 inside the vacuum vessel. Refer to Figure 3-16 for the hard ports (1) ~ (3) in the Table.

Table 3-3 Table of Hard Ports

No.	location	qty	bolt size*1	usage, etc.
(1)	TS supporting bench	45	M20	helisert insert attached
(2)	supporting bench with cooling panel	15	M20	helisert insert attached
(3)	body shroud	64	M12	
(4)	upper part of vacuum vessel	2		support for SBG
(5)	upper part of vacuum vessel			for optical bench maintenance*2
(6)	on optical bench	11	M16	guide for carrying in supporting bench*3
(7)	on work floor			*4

*1 Bolts are to be prepared by users.

*2 Even though “optical bench maintenance” is shown here as the nominal usage, the usage is not restricted and is at users’ choice.

*3 While these screw holes are used for mounting the guide for carrying in a TS supporting bench, they can be used as hard ports otherwise.

*4 By arranging attachment jigs, the rails on the work floor can be used.

The load capacities of the hard ports are shown below.

(1) TS supporting benches with and without cooling panel

Refer to Table 3-4 and Figure 3-17.

Table 3-4 Load Capacities of Hard Ports

No.	sign	name	load capacity*2
(1)	Fc	compressive load	37262.80 N (for vertical load)
(2)	Ft	tensile load	43146.4 kg (for vertical load)
(3)	Fx	X-direction load in horizontal plane	23534.4 N*1
(4)	Fy	Y-direction load in horizontal plane	23534.4 N*1
(5)	Mx	X-direction moment	1618 N・m
(6)	My	Y-direction moment	98.06 N・m

*1 It denotes the load capacity for shearing, but does not guarantee the prevention of lateral slippage.

*2 It denotes the load capacity for the TS supporting benches with and without a cooling panel, obtained based on safety factor $f = 3$.

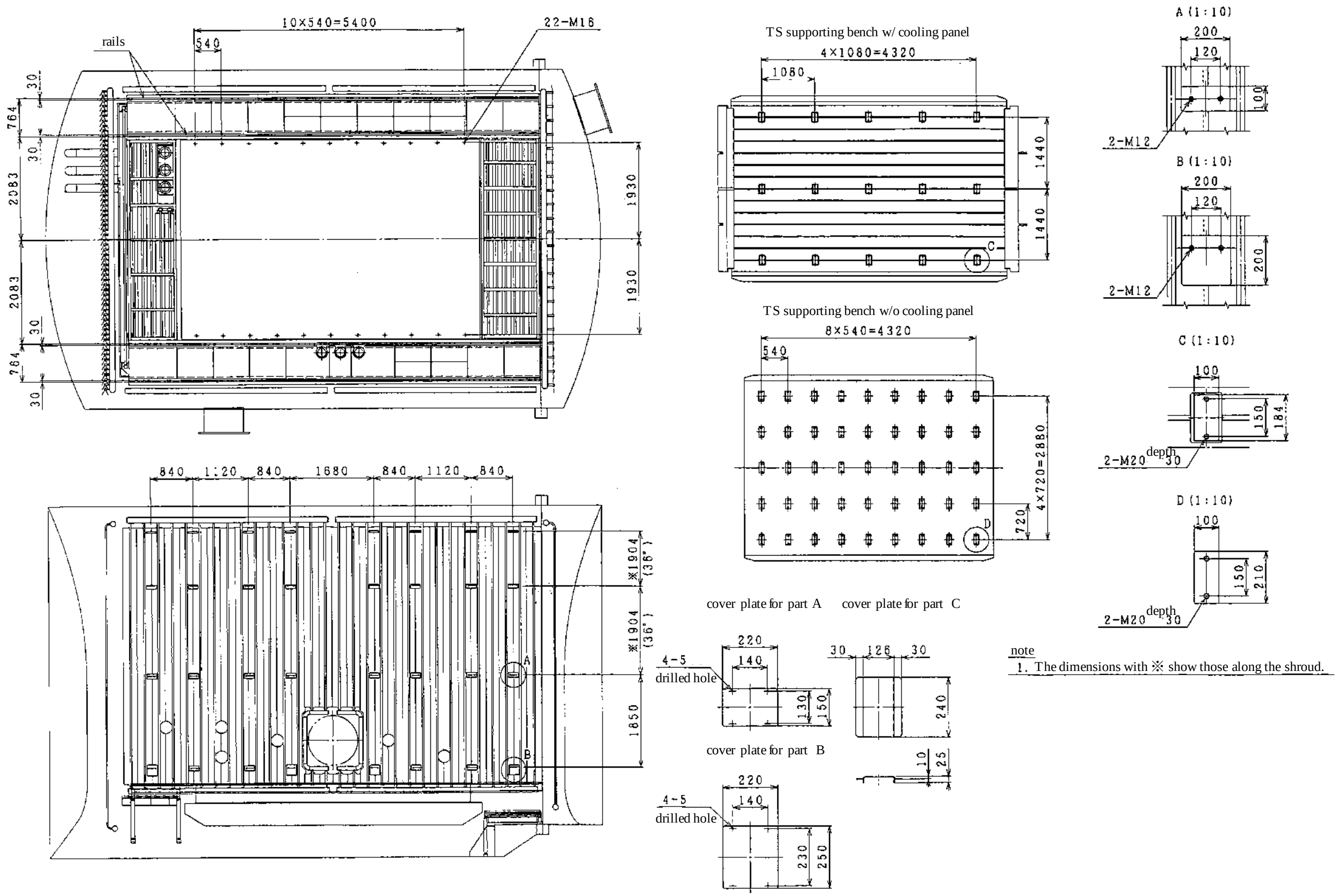


Figure 3-16 Configuration of Hard Ports

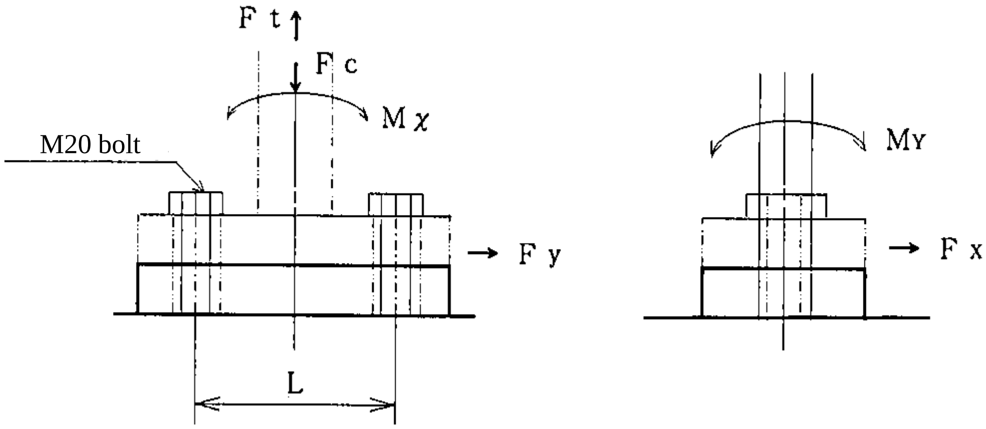


Figure 3-17 Load Capacity of Supporting Benches with and without Cooling Panel

(2) Body shroud

Refer to Table 3-5 and Figure 3-18.

Table 3-5 Load Capacity of Body Shroud Hard Ports

No.	sign	name	load capacity
(1)	Ft	tensile load	588.36N (for vertical load; the total weight per one shroud is to be under 600 kg.)
(2)	Fs	shearing load	294.18N (in the perpendicular direction to the axis; the total weight per one shroud is to be under 600 kg.)
(3)	M	moment	7.85 N・m (no more than 8 hard points are to be used per one shroud.)

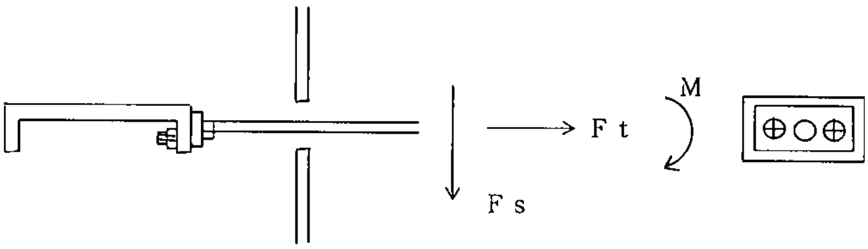


Figure 3-18 Load Capacity of Body Shroud Hard Port

(3) Upper part of vacuum vessel (support for SBG) ··· Refer to Figure 3-30 and section 3.3.2.1.

200 kg/ hard port (for vertical load)

(4) Upper part of vacuum vessel (for optical bench maintenance)

Even though these hard ports are for "optical bench maintenance", the usage is not restricted and is at users' choice as long as the method below is followed.

These hard ports are attached to the upper side of the vacuum vessel and cannot be used as they are. As shown in Figure 3-19, they require a rod to be inserted whose user-side mounting section is extended into the shroud, and users are to place a necessary mounting seat at the end of it.

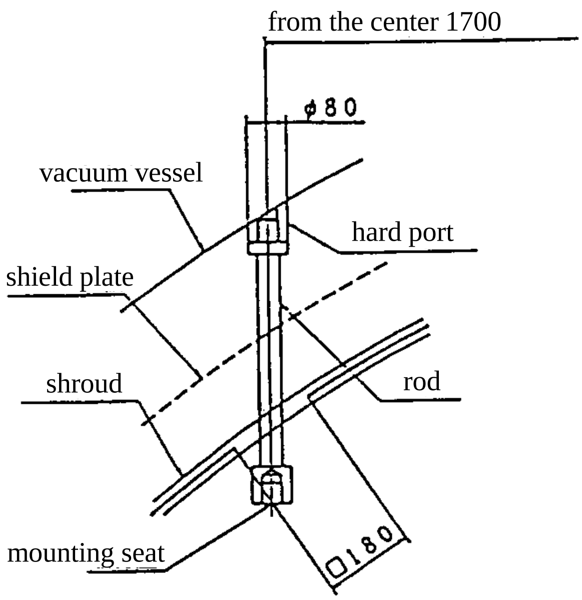


Figure 3-19 Schematic View of Hard Port for Optical Bench Maintenance

Pay attention to the following matters when inserting a rod.

(a) Load capacity of hard port: 4,500 kg (for vertical load)

(b) Opening dimensions of the shroud: 180 × 180

That is, the maximum dimensions of the rod are to be manufactured the way they do not exceed the limit of enabling it to go through the feed-through hole. Furthermore, there may be manufacture errors between the vacuum vessel and the shroud, and therefore a rod is to be manufactured with its shroud-feed-through part in as minimized dimensions as possible.

(c) Rod configuration: Be sure to place a mounting seat at the end of a rod to prevent seizure at the thread part when bending load acts on the rod; that way, the thread part can be protected from the direct impact of bending load.

(d) Prevention of seizure: The hard ports being SUS 304 products, a rod made of stainless steel requires caution not to cause seizure at the thread parts. When using a seizure-preventing agent, make sure to choose one that does not have bad influence on a TS or the vacuum vessel with its outgas, etc.

(5) On optical bench

Refer to Table 3-6.

Table 3-6 Load Capacity of Hard Ports on Optical Bench

No.	sign	name	load capacity
(1)	Ft	tensile load	13728.4N (vertical direction)
(2)	M	moment	23.53 N・m

(6) Notes

As mentioned in section 2.2.6, the chamber foundations are isolated from the seismic slab which has an optical bench mounted upon it. When performing an optical property confirmation test that takes account of micro vibration, make sure to prevent the vibration from the vacuum vessel not to be transmitted via hard ports. (ex. by tying the tie-wrap that fixes a TS to the body shroud.)

3.3.1.4. Thermal I/F on TS Supporting Bench

(1) Supporting bench without cooling panel

The TS supporting bench without a cooling panel cannot be cooled because it is not equipped with an LN_2 circulating structure. Meanwhile, the bench has heaters attached to it, which heat the bench during a test. In other words, it is the balance between cooling by radiation cooling and heating with the heaters that determines the temperature of the bench. Keep that point in mind when using the TS supporting bench without a cooling panel.

(2) Supporting bench with cooling panel

The TS supporting bench with a cooling panel can be deliberately cooled with its attached panel through which LN_2 circulates. The hard ports where a TS or a jig is mounted are thermally insulated from the parts where LN_2 runs through. That is, the hard ports are cooled only by radiation cooling. Meanwhile, the bench is heated by a heater as with the supporting bench without a cooling panel. Therefore, enough level of heat insulation is necessary when mounting a TS or a jig.

3.3.1.5. TS Cooling/Heating I/F

(1) General description

When a jig is manufactured for controlling temperature from the TS side, there are flanges available in the vacuum vessel that supply LN_2 and GN_2 for partially cooling and heating a TS, respectively. Refer to Figure 3-20 regarding to ports for TSs. Some of those flanges are for cooling the work floor and others are dedicated for a supporting bench with a cooling panel (cf. Table 3-7.)

Table 3-7 List of TS LN_2 Lines

No.	line No.	location	application purpose
(1)	LN-3145-20-3HV	body	cooling work floor / TS
(2)	LN-3146-20-3HV	head	cooling work floor
(3)	LN-3147-20-3HV	head	cooling TS
(4)	LN-3148-20-3HV	body	cooling TS
(5)	LN-3149-20-3HV	body	cooling TS

Table 3-8 General Description of TS Cooling/Heating I/F

LN_2 line for partial cooling of TS	GN_2 line for partial heating of TS
・20A × 5 lines ・N-32 nozzle (cf. Figure 3-20) CASE.1 shroud on supporting bench lower plane being not used (4 lines are available for the TS side) head (2 lines): for work floor – 1 line for TS – 1 line body (3 lines): for TS – 3 lines CASE.2 shroud on supporting bench lower plane being cooled (3 lines are available for test t item side) head (2 lines): for work floor / shroud on lower plane of supporting bench – 1 line for TS – 1 line body (3 lines): for work floor / shroud on lower plane of supporting bench – 1 line for TS – 2 lines	・150A × 3 lines ・N-24 nozzle (Figure 3-20) supply temperature: normal temperature ~ 60℃ supply pressure: 0.098 ~ 0.148 MPa

(2) Feed rate of LN_2 and GN_2

(a) The supply conditions of the LN_2 supply line are shown in Table 3-9 below.

Table 3-9 Rough Levels of LN_2 Feed Rate and Valve Opening Percentage

feed rate (Nm^3/h)	50	60	70
valve opening percentage (%)	24	27	31

The gasification rate is 35%, and the supply pressure is about 0.098 ~ 0.148 MPa.

(b) As for the GN_2 supply line, the feed rate is 30 Nm^3/h and the supply pressure is about 0.098 ~ 0.158 MPa for the valve opening percentage of 46%.

(3) LN_2 supply ports

The LN_2 supply ports are connected via Grayloc Connectors (cf. Figure 3-21, tightening torque 260 kg・cm.) Users are to pay attention to the following matters when laying pipes via the Grayloc Connectors by themselves. (The same cautions are required when laying SBG systems explained in section 3.3.2.1.)

(a) The hubs and seal rings shown in Figure 3-21 are to be prepared by users.

(b) Since it normally takes 3 months to have the hubs of Grayloc Connectors procured (seal rings also take long for procurement), users are to confirm with the manufacturer (NIKKISO CO., LTD.) for the procurement lead time when they plan the manufacturing process for laying pipes.

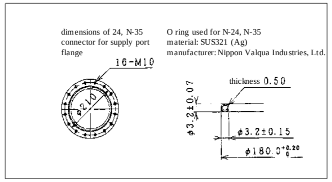
(4) GN_2 supply ports for heating TS

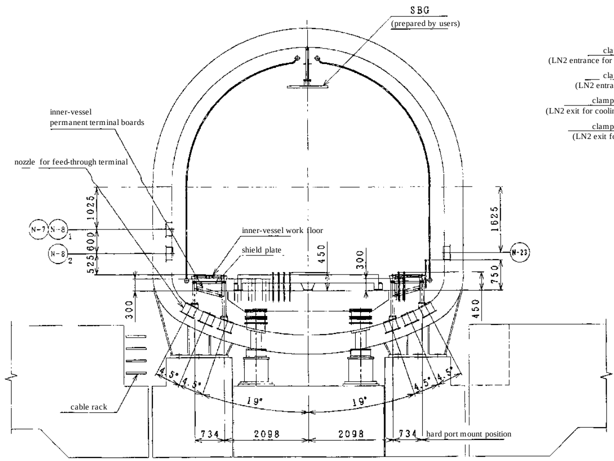
There are three GN_2 supply ports for heating a TS in this facility with their inlets at the chamber head and outlets on the body (cf. Figure 3-20.) The ports have a 150A special VG flange that adopts a metal tubal O ring. Therefore, users are to pay attention to the following matters when laying pipes by themselves.

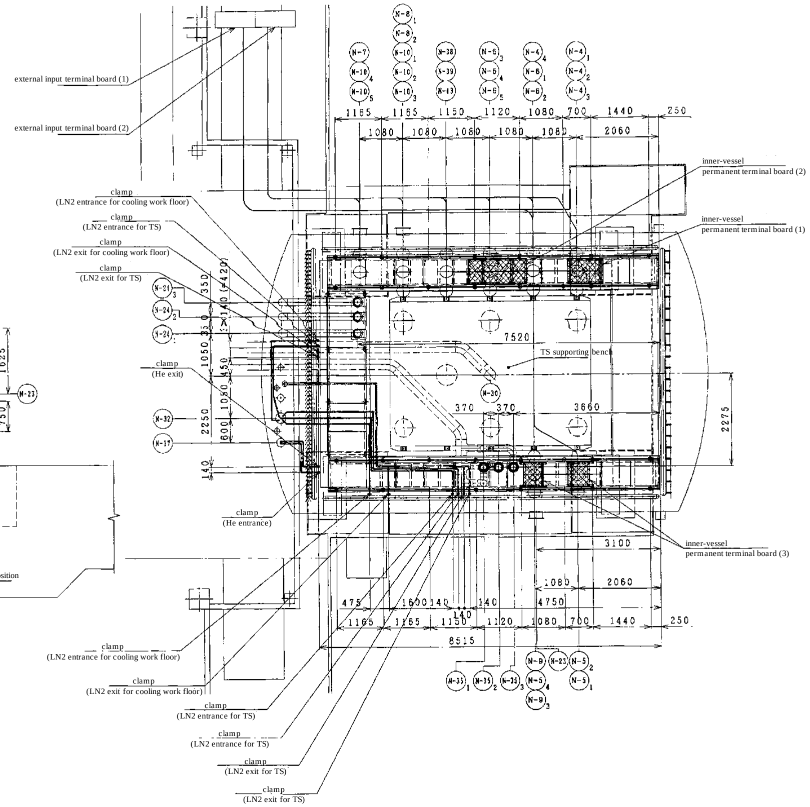
(a) The metal tubal O rings (cf. Figure 3-20) and connection pipes are to be prepared by users.

(b) Since it normally takes one month to have metal tubal O rings delivered, it is recommended that they be ready beforehand. Also, refer to Figure 3-22 which depicts how the flanges of GN_2 nozzles are manufactured, when planning for laying pipes.

N-24 TS heating GN2 entrance
N-35 TS heating GN2 exit

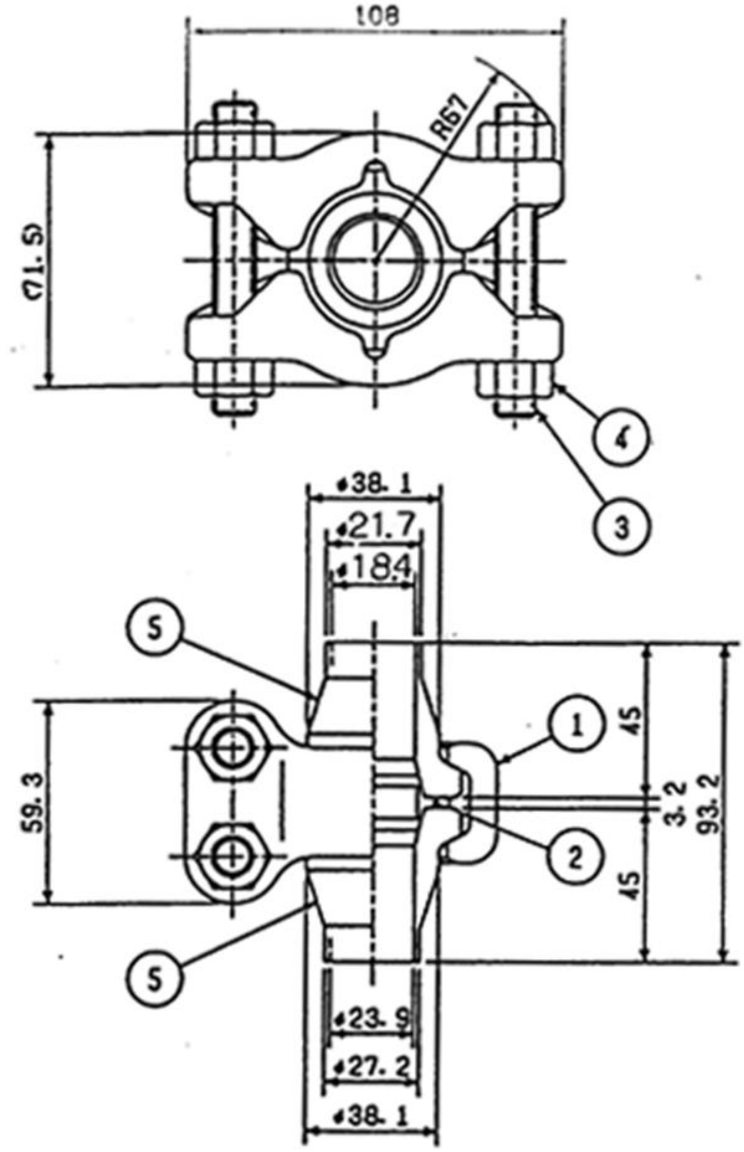






sign	nominal φ	quantity	format	name	note
N-39	300A	1	JIS VG	for facility, SBG temperature (incl. TQCM)	
N-38	300A	1	JIS VG	for facility & shroud temperature measurement	
N-35	150A	3	JIS SVG	GN2 exit	for heating TS
N-32	20A	5	clamp	for partial cooling of TS (IR gauge)	LN2 exit
N-32	20A	5	clamp	for partial cooling of TS (IR gauge)	LN2 entrance
N-30	250A	1	JIS VG	GN2 exit	for heating TS
N-24	150A	3	JIS SVG	GN2 entrance	for heating TS
N-23	300A	1	JIS VG	current inlet terminal	for analyzing vibration
N-17	20A	1	clamp	He piping	He exit
N-17	20A	1	clamp	He piping	He entrance
N-10	300A	5	JIS VG	spare nozzles	
N-9	300A	1	JIS VG	current inlet terminal (200V 10A)	for TS EP
N-8	300A	2	JIS VG	for waveguides	nozzles only
N-7	300A	1	JIS VG	high frequency output signals (coaxial)	
N-6	300A	5	JIS VG	current inlet terminal (100V 5A)	for TS signals
N-5	300A	4	JIS VG	current inlet terminal	for IR power supplies
N-4	300A	4	JIS VG	for CC thermocouples (incl. calorimeters, spares)	for TS thermocouples

Figure 3-20 System Diagram of Ports for TS



item	name	material	quant	description
6				
5	welded hub	SUSF304	18 sets	1GR8 (GL-32-4815)
4	nut	SA194-Gr8	36 sets	M12×1.75
3	bolt	SA193-B8	18 sets	M12×1.75×L89
2	seal ring	17-4PH/PT-24	18	NO.8
1	clamp	SA182-F304	18 sets	1GR8

Figure 3-21 Diagram of Grayloc Connector for LN_2

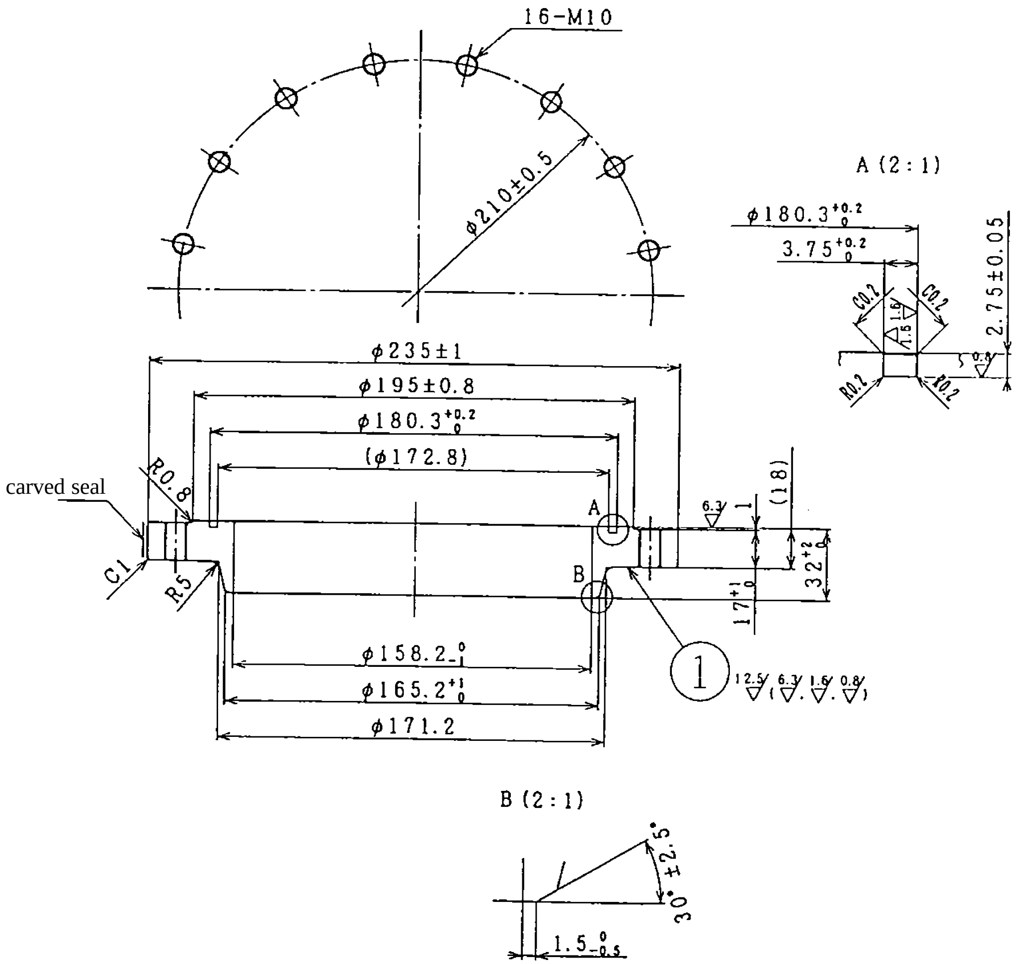


Figure 3-22 Diagram of Supply Port Flange for GN_2

3.3.1.6. I/F on TS Installation Device

A typical procedure of carrying in a TS into the vacuum vessel is shown in Figure 3-23. The operation of the installation device is basically executed by the facility side.

The assemble work for a TS is performed on the TS installation dolly.

The maximum load capacities on the moving dolly and the TS installation dolly are presented in section 2.2.2. Their load capacities vary when the CG of a loaded item deviates from their centers. Therefore, the CG of a loaded item is to be aligned as close as possible to the center of the TS installation dolly. In case the total weight of a TS and a jig exceeds 2,000 kg while their CGs deviate from the center of the TS installation dolly, contact the facility operation company in advance.

3.3.1.7. Optical Window and Alignment Window

There are three sets of optical window mounting flanges and nineteen sets of alignment windows installed in the vacuum vessel. For their mounting I/F positions, refer to Figure 3-3.

(1) Optical window flange

The structure of an optical window flange is shown in Figure 3-24. Users are to prepare optical glass and flanges referring to this Figure when using the optical window. The surface roughness on the contact face to the facility-side flange is to be 50 μm or less. An optical window flange has an adjustment mechanism which allows the controlling of the slant that can be up to 5.067×10^{-4} rad after vacuuming in the vacuum vessel down to 1 minute (2.9×10^{-4} rad.) The facility possesses an optical window and mounting flanges that used to be applied in the old radiometer space chamber. Their specifications and drawings are shown in Figure 3-25.

(2) Alignment window

There are alignment windows for the purpose of alignment measurement on a TS. Besides the permanently-equipped alignment window glass which is made of tempered glass, there are eight (4 concentric-type and another 4 eccentric-type) alignment windows (φ96) made of glass (BK7) with a highly-accurate transmission wave front, which can replace the permanently-equipped alignment window prior to the execution of a test to satisfy test requirements. Moreover, a theodolite and an ITV device (portable) shown in section 2.2.8 can be set on the alignment window.

When removing the tempered glass from the alignment window, lay air packing, etc., by way of caution to prevent damage on the tempered glass in case it is dropped.

The heights from the TS supporting bench to the optical window and to the center of the alignment window are shown in Figure 3-26.

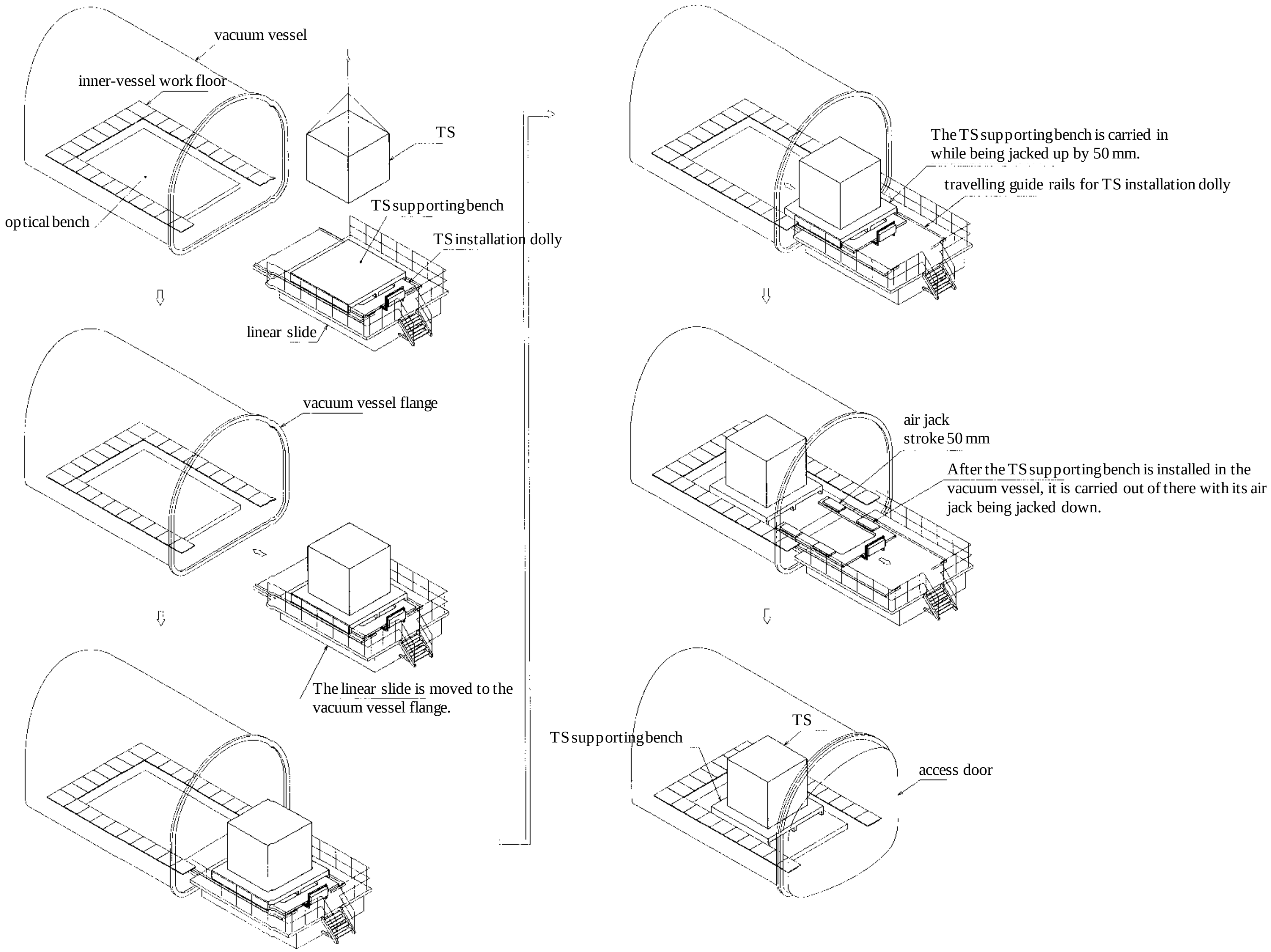


Figure 3-23 Procedure of TS Installation

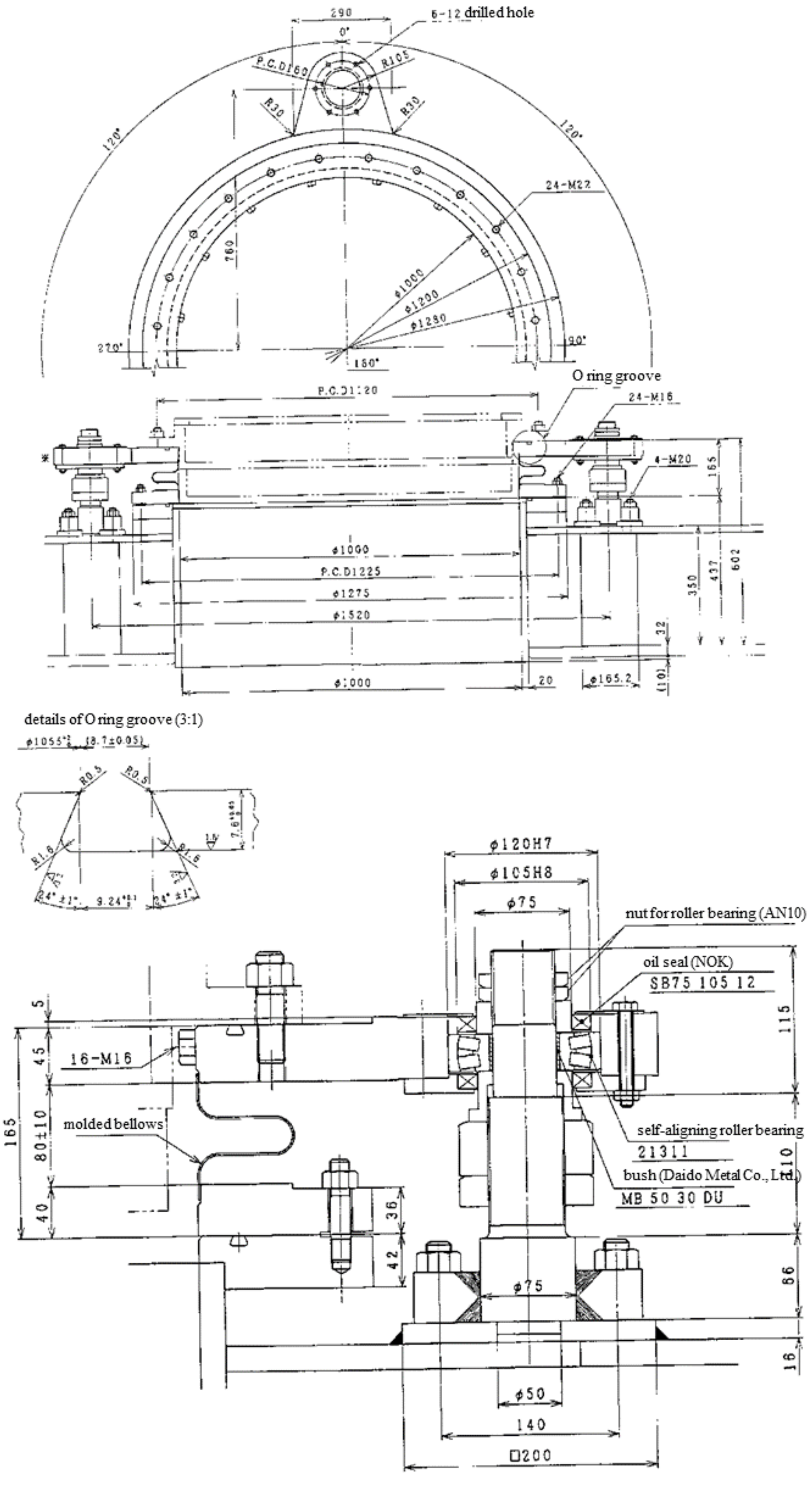


Figure 3-24 Diagram of Optical Window Mounting Flange

note) 1. The accuracy of the transmission wave front on the $\varphi 50$ in the effective diameter $\varphi 96$ is within 0.1 μm.
2. The uniformity of material is $\Delta n = 5 \times 10^{-6}$ or less.

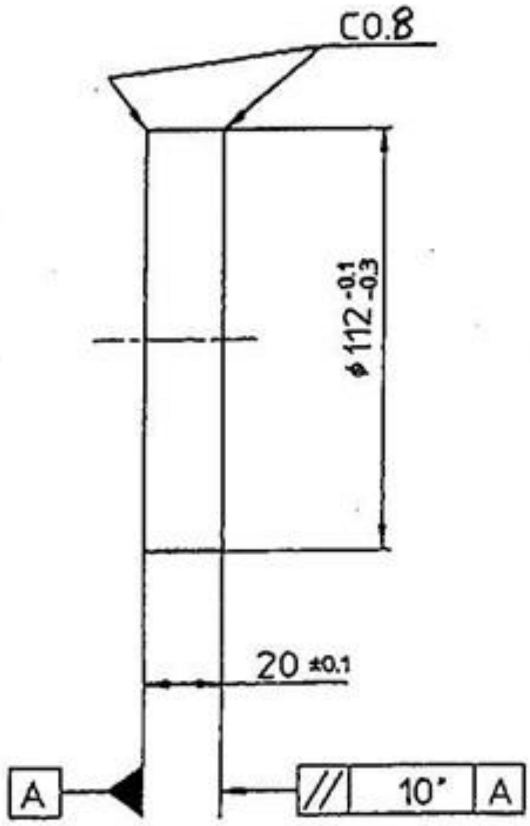


Figure 3-25 Optical Window

sign	nominal φ	quant	format	name	note
$N\text{-}2_1$	1000φ	1	VG	optical window	vacuum vessel straight cylindrical body
$N\text{-}2_2$	1000φ	1	VG	optical window	vacuum vessel straight cylindrical body
$N\text{-}2_3$	1000φ	1	VG	optical window	vacuum vessel access door
$N\text{-}3_1$	250A	1	VG	alignment window	vacuum vessel straight cylindrical body
$N\text{-}3_2$	250A	1	VG	alignment window	upper part of optical window
$N\text{-}3_3$	250A	1	VG	alignment window	vacuum vessel straight cylindrical body
$N\text{-}3_4$	250A	1	VG	alignment window	vacuum vessel straight cylindrical body
$N\text{-}3_5$	250A	1	VG	alignment window	upper part of optical window
$N\text{-}3_6$	250A	1	VG	alignment window	vacuum vessel straight cylindrical body
$N\text{-}3_7$	250A	1	VG	alignment window	vacuum vessel access door
$N\text{-}3_8$	250A	1	VG	alignment window	upper part of optical window
$N\text{-}3_9$	250A	1	VG	alignment window	vacuum vessel access door
$N\text{-}3_{10}$	250A	1	VG	alignment window	vacuum vessel access door
$N\text{-}3_{11}$	250A	1	VG	alignment window	vacuum vessel access door
$N\text{-}3_{12}$	250A	1	VG	alignment window	vacuum vessel ceiling
$N\text{-}3_{13}$	250A	1	VG	alignment window	vacuum vessel ceiling
$N\text{-}3_{14}$	250A	1	VG	alignment window	vacuum vessel ceiling
$N\text{-}3_{15}$	250A	1	VG	alignment window	vacuum vessel straight cylindrical body
$N\text{-}3_{16}$	250A	1	VG	alignment window	vacuum vessel straight cylindrical body
$N\text{-}3_{17}$	250A	1	VG	alignment window	$N\text{-}1_1$ upper part of man door
$N\text{-}3_{18}$	250A	1	VG	alignment window	vacuum vessel straight cylindrical body
$N\text{-}8_1$	300A	1	VG	for waveguides/ alignment window	vacuum vessel straight cylindrical body

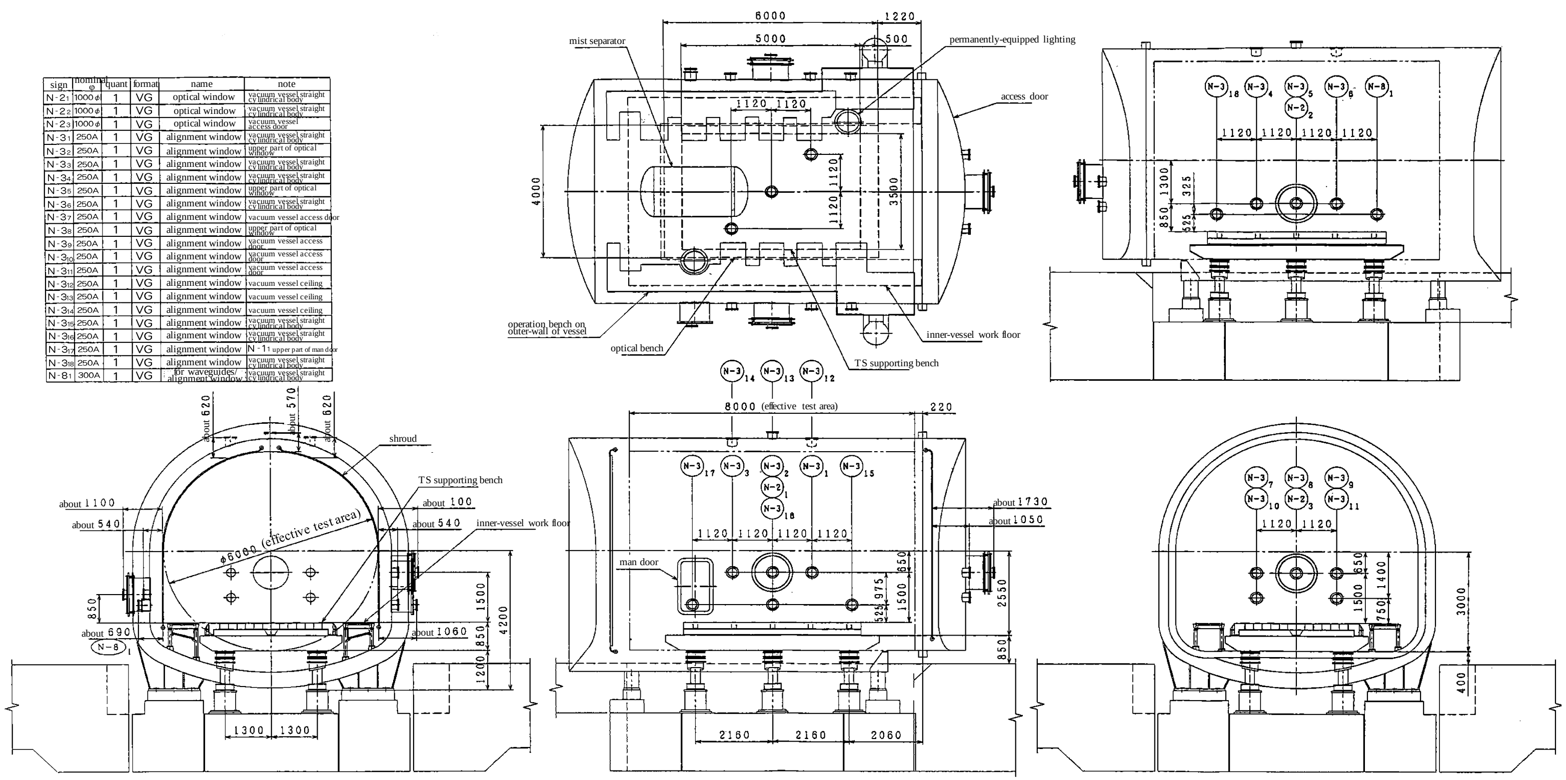


Figure 3-26 Mounting Positions of Optical Windows

3.3.1.8. Others (Inner-Vessel Work Floor, Movable Operation Bench, Working Platform)

(1) Work floors inside vacuum vessel (cf. Figure 3-27)

The work floors inside the vessel are used for the work to be performed on them after carrying in a TS into the vacuum vessel. The load capacity of the work floor is 150 kg / piece.

(2) Movable operation bench (cf. Figure 3-28)

There is a movable operation bench for accessing the man door and the optical window. It is available to users when necessary.

(3) Working platform (cf. Figure 3-29)

There is a working platform for mounting an SBG or accessing the upper part of a TS in the vacuum vessel. The maximum load mass and usable dimensions are shown below. The assembly and operation of the platform are to be executed by users.

(a) Max. load mass

①	Working platform floor	150 kg
②	Working platform flip-up floor	100 kg
③	Working platform ladder	100 kg

(b) Usable dimensions

①	Max. usable height	3,505 mm
②	Storage height	1,705 mm

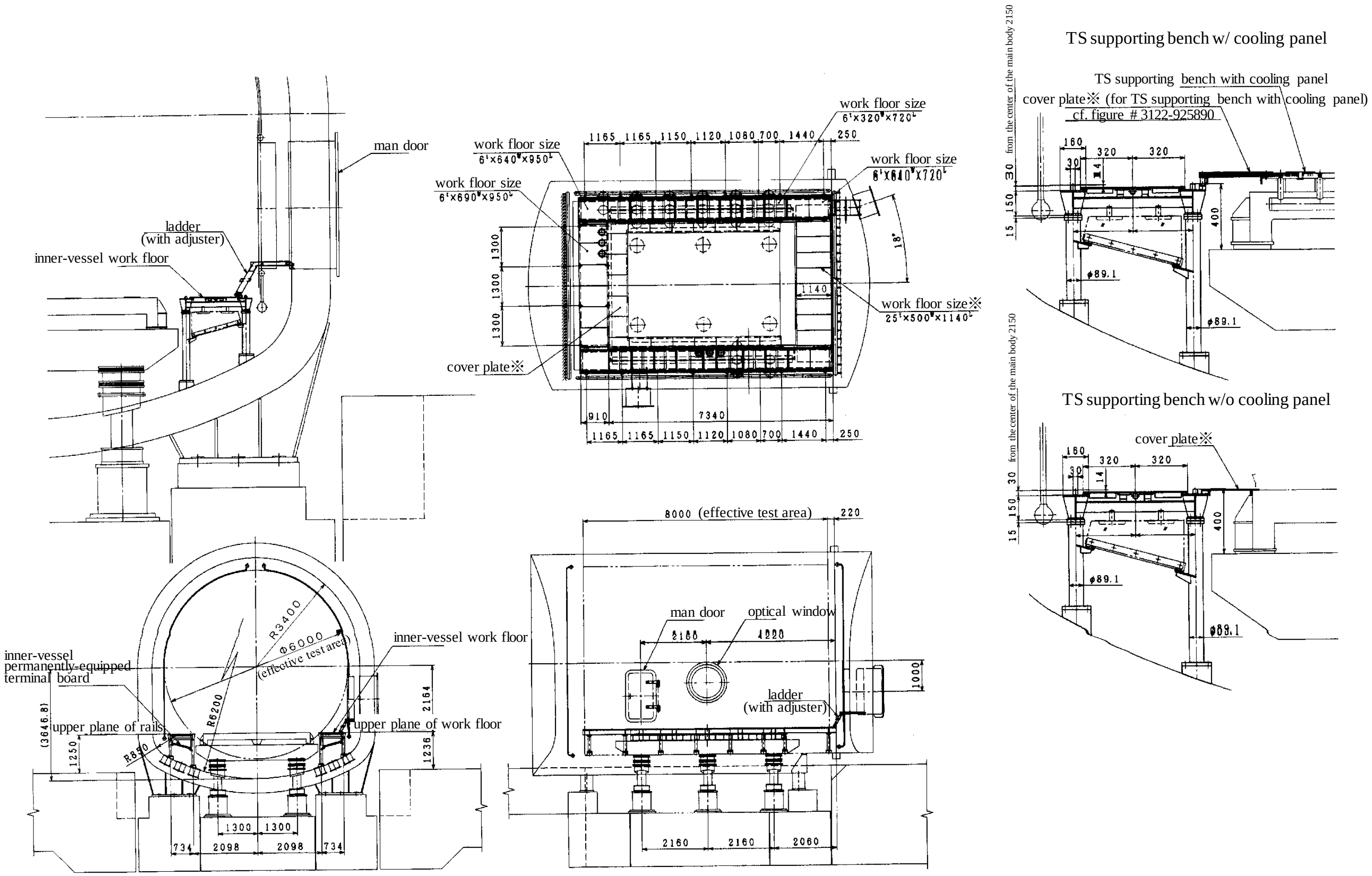


Figure 3-27 Work Floors inside Vacuum Vessel

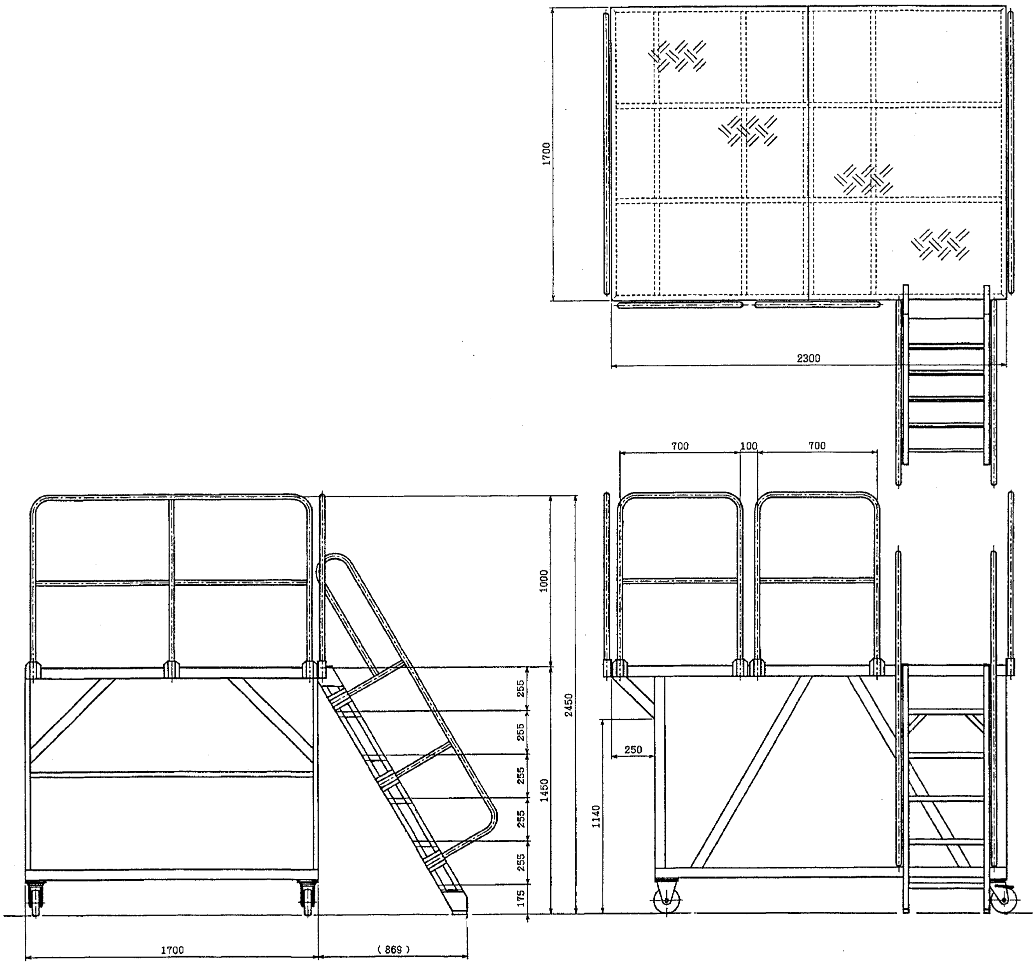


Figure 3-28 Movable Operation Bench

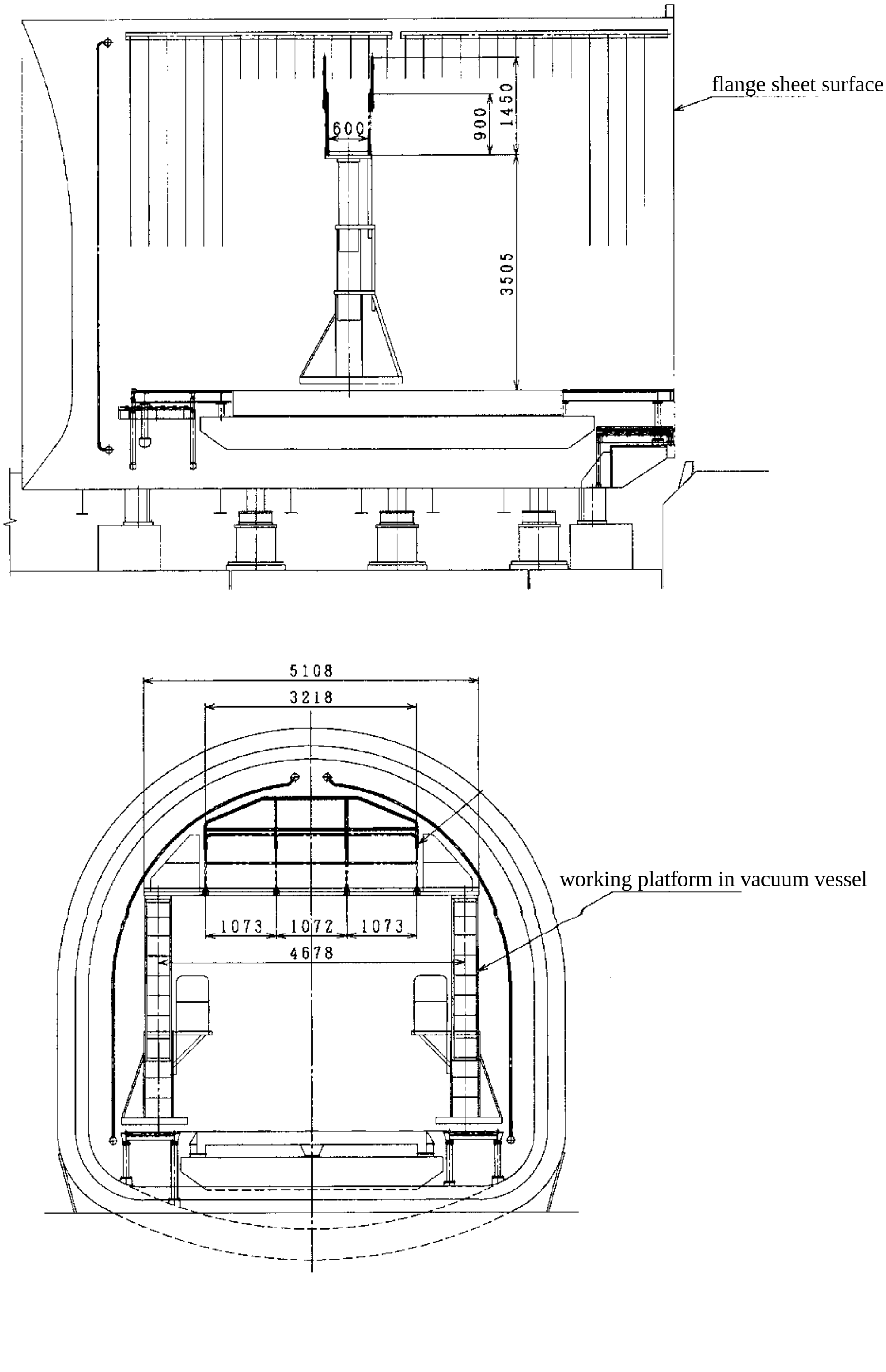


Figure 3-29 Working Platform

3.3.2. Power Supplies for Heat Sources

(1) Composition of components

The composition of primary components in the power supplies for heat sources and a system diagram of the holistic system are shown in Table 3-11 and Figure 3-33, respectively. Also, an inter-connection diagram of power supply racks is shown in Figure 3-34.

Table 3-11 Composition of Primary Components in Power Supplies for Heat Sources

name of component	model #, etc.	qty	note
(1) controller	HF-W7500 / model 30LX	1	
(2) setting PC	Endeavor Pro7500	1	
(3) power supplies for heat sources			qty of power supplies:
(a) 6mφ 60W power supply rack -1	by AES/ Matsusada Precision Inc.	1 set	25
(b) 6mφ 2 kW power supply rack -1	by AES/ Matsusada Precision Inc.	1 set	10
(c) 6mφ 2 kW power supply rack -2	by AES/ Matsusada Precision Inc.	1 set	10
(d) 6mφ 3 kW power supply rack -1	by AES/ Matsusada Precision Inc.	1 set	10

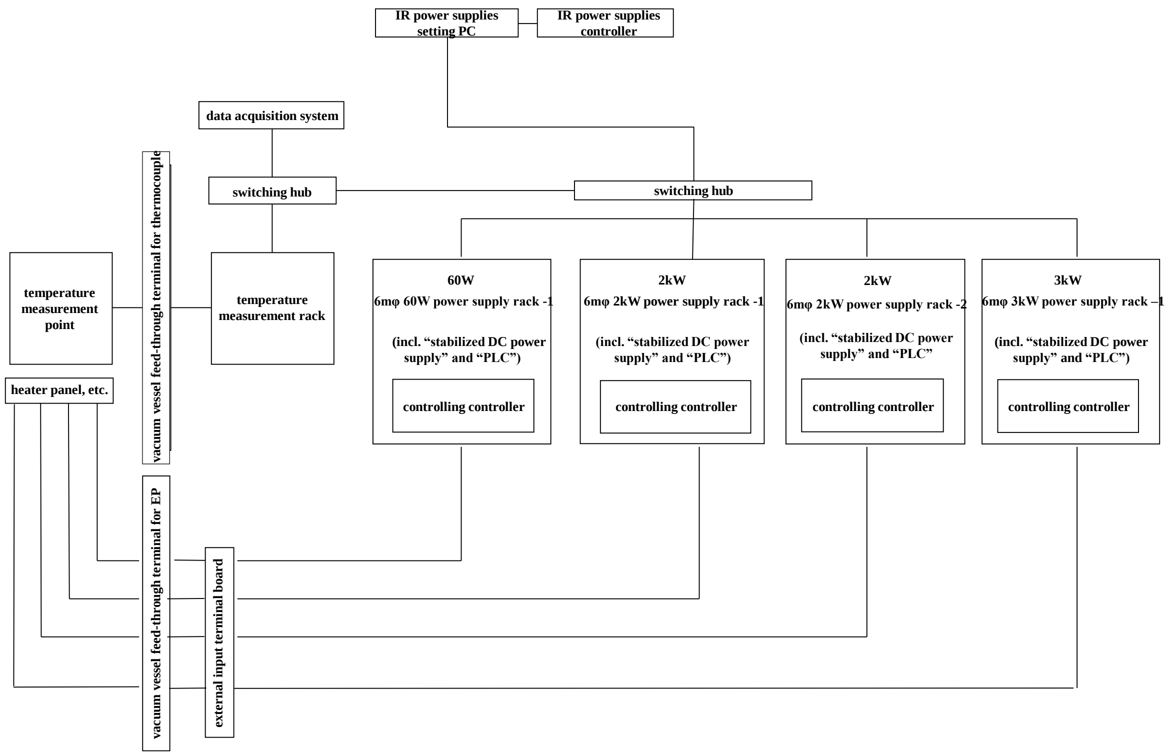


Figure 3-33 System Diagram of Holistic System

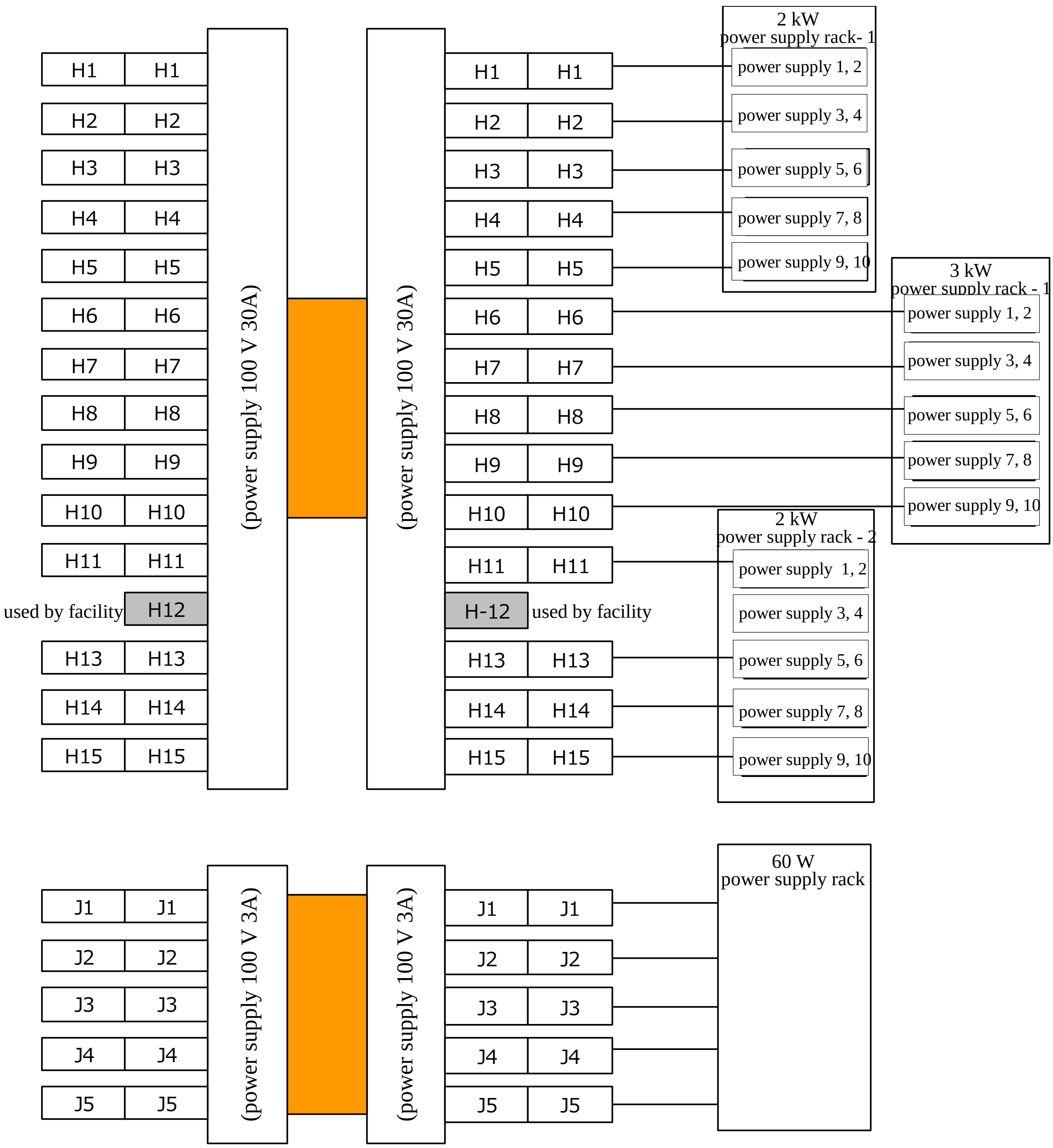


Figure 3-34 System Diagram of Power Supply Racks for IR Heaters

3.3.3. Control Mode

3.3.3.1. Control System

(1) Control system of this power supply rack

The control system of power supply racks is shown in the following Table 3-12.

Table 3-12 Control System of Power Supply Rack

<table>
<tr><td rowspan="9">control</td><td rowspan="5">temperature control in broad definition</td><td rowspan="4">PID control (=temperature control)</td><td>based on temperature at one point</td></tr>
<tr><td>based on averaged temperature among multiple points</td></tr>
<tr><td>based on temperature difference at one point</td></tr>
<tr><td>based on averaged temperature difference among multiple points</td></tr>
<tr><td colspan="2">ON/OFF control</td></tr>
<tr><td rowspan="2">constant power control</td><td colspan="2">with load resistance value input</td></tr>
<tr><td colspan="2">without load resistance value input</td></tr>
<tr><td>manual voltage output control</td><td colspan="2"></td></tr>
<tr><td>local control</td><td colspan="2"></td></tr>
</table>

(2) Grouping of multiple power supplies

Power supplies can be grouped for simultaneous operation. The grouping is possible only for the power supplies on the same rack. The grouping of power supplies for simultaneous controlling can only be applied to PID control and ON/OFF control.

3.3.3.2. Temperature Control

PID control denotes the controlling of temperature by using the PID commands sent from a PLC. The control methods and descriptions of PID control are shown in Table 3-13 below:

Table 3-13 Control Methods and Descriptions of PID Control (1/2)

<table>
<tr><th>control</th><th>number of controlled channels</th><th colspan="2">target point(s) of temperature control</th><th>brief description of controlling</th></tr>
<tr><td>based on temperature at one point</td><td>1 temperature channel</td><td colspan="2">—</td><td>The temperature of 1 temperature channel is controlled to be as designated.</td></tr>
<tr><td>based on averaged temperature among multiple points</td><td>Max of 10 temperature channels</td><td colspan="2">—</td><td>The average temperature of multiple temperature channels is controlled to be as designated.</td></tr>
<tr><td rowspan="5">based on temperature difference at one point</td><td rowspan="5">1 temperature channel</td><td colspan="2">1 temperature channel</td><td>The temperature of 1 temperature channel is controlled to be at a constant difference from the temperature of a reference control temperature channel.</td></tr>
<tr><td rowspan="2">1 power supply</td><td>control power supply based on temperature at one point</td><td>The temperature of 1 temperature channel is controlled to be at a constant difference from the temperature of a temperature channel of the reference control power supply.</td></tr>
<tr><td>control power supply based on averaged temperature among multiple points</td><td>The temperature of 1 temperature channel is controlled to be at a constant difference from the average temperature of multiple temperature channels of the reference control power supply.</td></tr>
<tr><td rowspan="2">power supply group</td><td>control based on temperature at one point</td><td>The temperature of 1 temperature channel is controlled to be at a constant difference from the temperature of a temperature channel designated by the reference control power supply group.</td></tr>
<tr><td>control based on averaged temperature among multiple points</td><td>The temperature of 1 temperature channel is controlled to be at a constant difference from the average temperature of multiple temperature channels designated by the reference control power supply group.</td></tr>
</table>

Table 3-13 Control Methods and Descriptions of PID Control (2/2)

<table>
<tr><th>control</th><th>number of controlled channels</th><th colspan="2">target point(s) of temperature control</th><th>brief description of controlling</th></tr>
<tr><td rowspan="5">based on averaged temperature difference among multiple points</td><td rowspan="5">Max of 10 temperature channels</td><td colspan="2">1 temperature channel</td><td>The average temperature of multiple temperature channels is controlled to be at a constant difference from the temperature of a reference control temperature channel.</td></tr>
<tr><td rowspan="2">1 power supply</td><td>control power supply based on temperature at one point</td><td>The average temperature of multiple temperature channels is controlled to be at a constant difference from the temperature of a temperature channel of the reference control power supply.</td></tr>
<tr><td>control power supply based on averaged temperature among multiple points</td><td>The average temperature of multiple temperature channels is controlled to be at a constant difference from the average temperature of multiple temperature channels of the reference control power supply.</td></tr>
<tr><td rowspan="2">power supply group</td><td>control based on temperature at one point</td><td>The average temperature of multiple temperature channels is controlled to be at a constant difference from the temperature of a temperature channel designated by the reference control power supply group.</td></tr>
<tr><td>control based on averaged temperature among multiple points</td><td>The average temperature of multiple temperature channels is controlled to be at a constant difference from the average temperature of multiple temperature channels designated by the reference control power supply group.</td></tr>
</table>

3.3.3.3. ON/OFF Control

The definition of on/off control is that temperature is controlled with the voltage output of a power supply turned off when the upper temperature limit is exceeded, and turned on when the lower temperature limit is exceeded.

For this control method, the preset ON/OFF control voltage is applied as the output voltage (ON/OFF control voltage ≦ voltage load tolerance.) On/off temperature control can only be achieved in controlling based on temperature at one point.

3.3.3.4. Constant Power Control

The constant power control function is based on the control methods as follows. Controlling is executed every 10 seconds.

(1) With input of load resistance value

Constant power control (with load resistance value input) denotes current control which keeps the theoretical current calculated from the specified power and load resistance levels. The basic idea is that a heater generates the specified power when theoretical current is applied to the heater. (Here, the variation of heater load resistance is not taken into account.) Based on the theory, the control current value to generate the target EP at the heater is calculated. Then, the calculated current/voltage values are transmitted to the power supply via LAN.

The EP of measurement data is obtained by the following equation.

EP (P) = $I^2 \times R$ [current × current × resistance]

(2) Without input of load resistance value

For constant power control (without load resistance input), initial current is applied to a circuit to obtain its resistance, from which to derive the current level required to achieve the constant control on the target output power (output voltage × output current) of a power supply, which is executed via feedback control. The circuit resistance is updated every 10 seconds for correction.

To be precise, the current levels at the forementioned process are varied in stages, during which the output voltage of a power supply is measured. Then the approximate circuit resistance is derived from the output voltage/current of the power supply, using which the output power from the power supply is controlled to achieve the target EP.

That is, a power supply is controlled the way its output EP, which is calculated from the output current/voltage of the power supply, achieves the preset target EP. The power supply is used in a constant current mode to ease the influence of the variation in load resistance. The output current/voltage from a power supply are obtained via LAN, to which then feedback controlling is applied.

3.3.3.5. Manual Voltage Output Control

Via the manual voltage output control function, voltage arbitrarily set by users can be output. To be precise, a power supply can be controlled the way the voltage preset in the “setting PC” or the “controller” can be output.

3.3.3.6. Local Control

When local control is designated for a power supply from the setting screen, the corresponding power supply can be locally operated on its own (by turning its current/voltage output knob.)

The power supplies for local controlling designated by the setting screen can also measure voltage/current output, which is sent to PC and recorded thereat, as in other controlling methods.

Local controlling is also applicable to the 60W power supplies pre-installed in the 6mφ chamber, as one of the controlling types they can deal with.

Local controlling is possible even when the “setting PC” and the “controller” are not in operation (data cannot be recorded in that case.)

3.3.4. Limit Function

The limit function can be classified into the three control operations as follows according to the detected items.

(1) Alert

When the limit that does not require the immediate stop of controlling is chosen to be applied, controlling is sustained while displaying an alert and outputting a PC alarm. It is up to users then whether or not to change control conditions or to take other countermeasures.

(2) Survival mode

When all the target temperature levels to be controlled turn out to be abnormal, temperature controlling is judged as not continuable. When temperature control is stopped, an immediate temperature drop of a TS is avoided by maintaining the heater output only to the ratio [%] preset as the control output for the survival mode case to that at the point of abnormality detection. (The percentage of sustained output is determined based on the output at the point when abnormal temperature output takes place.) Then, an alert shows up on the display while PC/power supply rack alarms go off.

(3) Control abort

Control is stopped when it cannot be sustained due to the abnormality of hardware. Then, an alert shows up on the display, while PC/power supply rack alarms go off and the stop/abnormality lamp turns on.

Tables 3-14 (1/3)(2/3)(3/3) show the items to be detected by the limit function, immediate control reactions, and the control methods in which the corresponding failures are prone to take place. Alerts are output to the setting PC and power supply racks. Table 3-15 shows the actions of alert for individual detected phenomena.

Table 3-14 Table of Limit Functions (1/3)

	detected item	content	control reaction	PID control				ON/OFF control	constant power control	manual voltage output control
				based on temperature at one point	based on averaged temperature among multiple points	based on temperature difference at one point	based on averaged temperature difference among multiple points			
(1)	preset temperature limit	Control temperature exceeded the preset temperature upper limit.	alert	○				○		
		Control temperature exceeded the preset temperature lower limit.	alert	○				○		
(2)	average temperature limit	Average control temperature exceeded the average temperature upper limit.	alert		○					
		Average control temperature exceeded the average temperature lower limit.	alert		○					
(3)	temperature difference limit	Control temperature difference exceeded the preset upper limit.	alert			○				
		Control temperature difference exceeded the preset lower limit.	alert			○				
(4)	average temperature difference limit	Control temperature difference exceeded the preset upper limit.	alert				○			
		Control temperature difference exceeded the preset lower limit.	alert				○			
(5)	temperature overchange abnormality	Temperature change of over 10℃ in 10 secs was observed in control temperature.	alert	○	○	○	○	○		
		Temperature change of over 10℃ in 10 secs was observed for 30 secs in control temperature.	survival mode	○	○	○	○	○		

Table 3-14 Table of Limit Functions (2/3)

	detected item	content	control reaction	PID control				ON/OFF control	constant power control	manual voltage output control
				based on temperature at one point	based on averaged temperature among multiple points	based on temperature difference at one point	based on averaged temperature difference among multiple points			
(6)	temperature data abnormality	About all the target temperatures to be controlled; ・Temperature data cannot be acquired for 1 minute. ・Measurement failure due to wire breakage of thermocouple, for example, took place in temperature data.	survival mode	○	○	○	○	○		
(7)	preset EP upper limit	Control EP exceeded the preset EP upper limit.	alert						○	
(8)	output EP upper limit	EP load tolerance was exceeded, the excess being 1% or more to less than 5% of Max. power supply output EP.	alert	○	○	○	○	○	○	○
		EP load tolerance was exceeded, the excess being 5% or more of Max. power supply output EP.	control abort	○	○	○	○	○	○	○
(9)	output voltage upper limit	Voltage load tolerance was exceeded, the excess being 1% or more to less than 5% of Max. power supply output voltage.	alert	○	○	○	○	○	○	○
		Voltage load tolerance was exceeded, the excess being 5% or more of Max. power supply output voltage.	control abort	○	○	○	○	○	○	○
(10)	output current upper limit	Current load tolerance was exceeded, the excess being 1% or more to less than 5% of Max. power supply output current.	alert	○	○	○	○	○	○	○
		Current load tolerance was exceeded, the excess being 5% or more of Max. power supply output current.	control abort	○	○	○	○	○	○	○

Table 3-14 Table of Limit Functions (3/3)

	detected item	content	control reaction	PID control: based on temperature at one point	PID control: based on averaged temperature among multiple points	PID control: based on temperature difference at one point	PID control: based on averaged temperature difference among multiple points	ON/OFF control	constant power control	manual voltage output control
(11)	power supply abnormality	Abnormal data was received in STS command from power supply.	control abort	○	○	○	○	○	○	○
(12)	communication failure of power supply	Communication failure took place.	output maintained	○	○	○	○	○	○	○
(13)	heater wire breakage abnormality	When control input ≧ 2% of Max. output current AND current level ＜ 0.4% of Max. output current in current control (temperature/constant EP control), heater wire breakage abnormality is determined.	control abort	○	○	○	○	○	○	○
(14)	abnormal data from power supply	Measurement failure took place due to abnormality in data from power supply.	control abort	○	○	○	○	○	○	○
(15)	PLC abnormality	Abnormality took place during PID control.	survival mode	○	○	○	○			
		Abnormal response from PLC was received.	survival mode	○	○	○	○			
		Communication failure took place.	survival mode	○	○	○	○			
(16)	power failure detection	Power failure or dropping of breaker took place.	control abort	○	○	○	○	○	○	○
(17)	overcurrent detection	Overcurrent was supplied to power supply.	control abort	○	○	○	○	○	○	○

Table 3-15 Contents of Alert for Each Detection Item (1/2)

	detected item	content	control reaction	setting PC			power supply rack	
				setting screen	log message	alarm sound	abnormality lamp (red)	buzzer
(1)	preset temperature limit	Control temperature exceeded the preset temperature upper limit.	alert	light fault	alert	○		
		Control temperature exceeded the preset temperature lower limit.	alert	light fault	alert	○		
(2)	average temperature limit	Average control temperature exceeded the average temperature upper limit.	alert	light fault	alert	○		
		Average control temperature exceeded the average temperature lower limit.	alert	light fault	alert	○		
(3)	temperature difference limit	Control temperature difference exceeded the preset upper limit.	alert	light fault	alert	○		
		Control temperature difference exceeded the preset lower limit.	alert	light fault	alert	○		
(4)	average temperature difference limit	Control temperature difference exceeded the preset upper limit.	alert	light fault	alert	○		
		Control temperature difference exceeded the preset lower limit.	alert	light fault	alert	○		
(5)	temperature overchange abnormality	Temperature change of over 10℃ in 10 secs was observed in control temperature.	alert	light fault	alert	○		
		Temperature change of over 10℃ in 10 secs was observed for 30 secs in control temperature.	survival mode	heavy fault	abnormality	○		
(6)	temperature data abnormality	About all the target temperatures to be controlled; ・Temperature data cannot be acquired for 1 minute. ・Measurement failure due to wire breakage of thermocouple, for example, took place in temperature data.	survival mode	heavy fault	abnormality	○		
(7)	preset EP upper limit	Control EP exceeded the preset EP upper limit.	alert	light fault	alert	○		
(8)	output EP upper limit	EP load tolerance was exceeded, the excess being 1% or more to less than 5% of Max. power supply output EP.	alert	light fault	alert	○		
		EP load tolerance was exceeded, the excess being 5% or more of Max. power supply output EP.	control abort	heavy fault	abnormality	○	△	△

Table 3-15 Contents of Alert for Each Detection Item (2/2)

	detected item	content	control reaction	setting PC			power supply rack	
				setting screen	log message	alarm sound	abnormality lamp (red)	buzzer
(9)	output voltage upper limit	Voltage load tolerance was exceeded, the excess being 1% or more to less than 5% of Max. power supply output voltage.	alert	light fault	alert	○		
		Voltage load tolerance was exceeded, the excess being 5% or more of Max. power supply output voltage.	control abort	heavy fault	abnormality	○	△	△
(10)	output current upper limit	Current load tolerance was exceeded, the excess being 1% or more to less than 5% of Max. power supply output current.	alert	light fault	alert	○		
		Current load tolerance was exceeded, the excess being 5% or more of Max. power supply output current.	control abort	heavy fault	abnormality	○	△	△
(11)	power supply abnormality	Abnormal data was received in STS command from power supply.	control abort	heavy fault	abnormality	○	△	△
(12)	communication failure of power supply	Communication failure took place.	output maintained	heavy fault	abnormality	○	△	△
(13)	heater wire breakage abnormality	When control input ≧ 2% of Max. output current AND current level ＜ 0.4% of Max. output current in current control (temperature/constant EP control), heater wire breakage abnormality is determined.	control abort	heavy fault	abnormality	○	△	△
(14)	abnormal data from power supply	Measurement failure took place due to abnormality in data from power supply.	control abort	heavy fault	abnormality	○	△	△
(15)	PLC abnormality	Abnormality took place during PID control.	survival mode	heavy fault	abnormality	○		
		Abnormal response from PLC was received.	survival mode	heavy fault	abnormality	○		
		Communication failure took place.	survival mode	heavy fault	abnormality	○		

* △ denotes that the abnormality lamps and buzzers are turned on only on the power supply racks that contain abnormality-detected power supplies.

3.3.5. Vibration Control System

Among the work concerning the vibration control system, the preparatory work and operation of a vibration analyzer are to be executed by users. For using a vibration analyzer, users are to install accelerometers and cables, and set the analyzer itself by themselves. The points to be taken into account and cautions for the preparation and operation of a vibration analyzer are shown below. Ask the operation company of the facility for more details.

(1) Accelerometers for different usage purposes

As Table 2-8 shows, there are three kinds of accelerometers prepared in this system for different usage purposes according to resolution, applied temperature range, etc. The installation sites where they are used are mostly assumed as below.

(a) 393M33: inside vacuum vessel (shroud, supporting bench with cooling panel, vacuum vessel, optical window)

(b) 393B12: inside vacuum vessel (optical bench, TS supporting bench)

(c) 393B31: seismic slab

Those accelerometers are not restricted to the locations shown above; 393B31, for example, can be mounted on the TS supporting bench in the vacuum vessel, as long as thermal insulation measures were taken by protecting it with insulating materials, etc. (That way, it is applicable in vacuum.)

(2) Accelerometer I/F

(a) Cable connecting I/F

As you can see from Figure 2-11, the cable connection I/F inside and outside the vacuum vessel are different from each other. Inside the vacuum vessel, accelerometers are connected to the MIL connectors at the end of the low noise cables stored in the cutouts on the vacuum vessel body shroud. Outside the vessel, e. g., on the seismic slab, meanwhile, they are connected to the relay box in the lower pit of the vacuum vessel via twisted wire cables. The wiring from the relay box to the vibration analyzer is completed in advance. Accelerometers are designated to be assigned to the channels 1 ~ 15 for installation inside the vacuum vessel and to the channels 16 ~ 30 for installation outside the vessel. As for the former group of channels, the wiring between the inner-vessel MIL connectors and the relay box is completed in advance.

(b) I/F for installation

The general description of the I/F for installation is provided as follows.

In case there is not enough number of purpose-made plates mentioned below, users are to prepare them. Accelerometers can be fixed not only to the pre-designated places but anywhere using kapton tape, etc.

① Seismic slab

The seismic slab has screw holes for fixing an I/F on it for mounting accelerometers. That I/F is to be made for the specific purpose.

② Optical bench

Mount a purpose-made plate on the optical bench as the I/F, using the screw holes on it for mounting a TS supporting bench guide.

③ TS supporting bench

Mount a purpose-made plate on the TS supporting bench as the I/F using the hard ports on it.

④ Shroud

There are purpose-made mounting points near the man door on the body part.

⑤ Vacuum vessel

There are purpose-made mounting points near the manhole at the bottom of the vacuum vessel.

⑥ Optical window

There are purpose-made mounting points on three places at the bottom of the optical window.

(3) Cautions for executing analysis

Acceleration data can be obtained for three minutes at the sampling frequency of 800Hz due to the restriction of the hard disc capacity. Choose “monitor mode” (ask the operation company of the facility for details) when long-term monitoring is desired.

(4) Data transfer

The acceleration/displacement data acquired by the vibration analyzer and the FFT results obtained by post-processing those data are saved in the work station in binary format. There are three ways of transferring data as below (recording media is to be prepared by users.)

(a) Copy binary data on magnetic tape, and bring it out.

(b) Convert binary data to text data, copy it on a data storage device via LAN, and bring it out in MO.

(c) Copy binary data on a data storage device via LAN in a binary mode, and bring it out in MO (data can be corrupted during transference unless it is kept in a binary mode.)

When using magnetic tape, choose one with a capacity of 525 MB.

3.3.6. Data Acquisition System

3.3.6.1. Registration of Measurement Conditions

Input measurement conditions following the users’ manual for the system. (Information can be input in a form of a file.)

The format of the “measurement ID” to be made for measurement ID/mode settings is 8 alphanumeric letters. Do not use half-width spaces before and after a measurement ID.

3.3.6.2. Data Distribution

After a test, the recorded measurement data is to be CSV-converted and handed to a TS manufacturer.

3.3.6.3. Content of Data obtained by Data Acquisition System

The data obtainable by the data acquisition system are as follows.

- Thermocouple temperature
- Calorimeter output
- Temperature by resistance temperature detector (■abbreviated as RTD hereafter)
- T-QCM output
- IR power supply current/voltage output
- Vacuum pressure

Users can monitor those data from the data displaying devices 1 ~ 4.

The correspondence between the channel numbers of the input signals for the data acquisition system and the plug signs on the inner-vessel permanent terminal board are shown in Figure 3-4 and Table 3-16. According to them, for example, the thermocouple lines for a TS (600 channels in total) which do not go through IR power supplies correspond to the plugs C1 ~ C41, D1 ~ D6, N1~ N2 on the inner-vessel permanent terminal board, which correspond to the channel numbers 1 ~ 600 in the data acquisition system.

Table 3-16 Correspondence between Acquisition Data and Channel Numbers

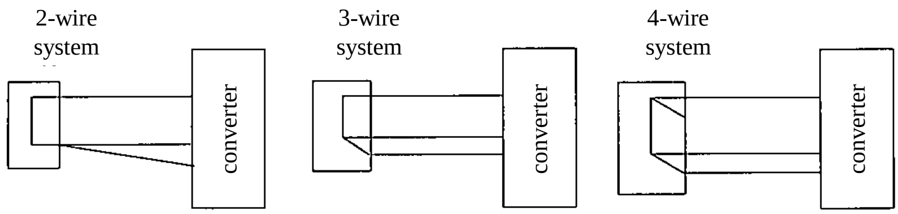
channel No.	plug sign	name of data
1～600	C1 ~ 41 D1 ~ 6 N1 ~ 2	TS temperature*
613～648	—	standard signals
601～612 649～672	—	spare
1001～1016	—	T-QCM
3001～3420	—	power supplies for heat sources

Refer to the correspondence table of channels in Appendix A for details.

* Among the pairs of pins, the 12th pair of C14 and C28 is occupied for grounding, which leaves 11 pairs available.

3.3.6.4. Resistance Temperature Detector

The output resistance of the RTDs to be connected is to be between 0 ~ 3 kW. They are basically to be JAXA-certified products. The resistance levels of measurement data are converted into temperature only via the data processing system. That is, they are displayed as they are in the data gathering system. Refer to the following figure for how RTDs are connected.



Note) The converters all have a three-wire system.

Figure 3-35 Connection of RTDs

Also, a conversion sheet for resistance and temperature is to be prepared in the tabular format of EXCEL. The data acquisition system generates an approximate line by connecting the values designated in the sheet with linear lines. Up to 32 contact points can be specified.

There are default conversion sheets for the ten kinds of RTDs as shown below.

(1) Thermistor (cf. NASDA-QTS-23648A)
- THS51CNA501, 102
- THS51CNB222, 302
- THS51CNC502
- THS51CND103
- THS51CNE153, 303

(2) Platinum temperature sensor (cf. NASDA-QTS-1043A)
- N1043501-90-300, N1043501-91-600

3.3.6.5. Wire Breakage Detection Function and How to Use it

(1) Wire breakage detection function

A detection circuit for wire breakage is installed for thermocouple-adopted temperature measurement to detect a broken wire in a thermocouple circuit by deflecting signals to the maximum limit, so that temperature can be controlled to the safety side. The detection circuit for wire breakage is of a voltage impression type as shown in Figure 3-36. When a thermocouple circuit has no defects, the detection current for wire breakage flows into a thermocouple.

(2) Wire breakage detection function in 6mφ Radiometer Space Chamber

The wire breakage detection function in this facility has a high resistance of 10 MΩ and voltage of 2.5V loaded on its input circuit as shown in Figure 3-36. That is, detection current of about 0.25 μA is flowing to the thermocouple side.

When this detection current for wire breakage is interrupted, the wire breakage of a thermocouple is detected.

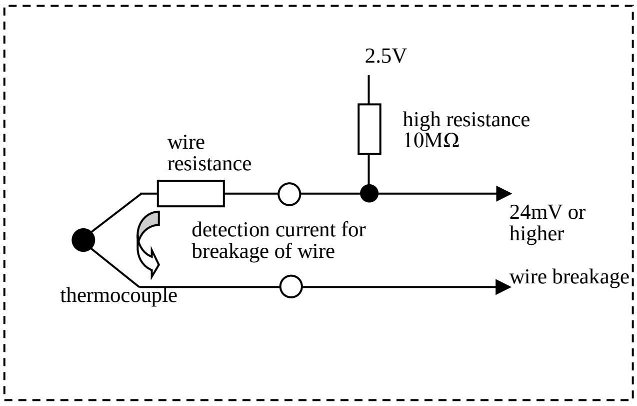


Figure 3-36 Wire Breakage Detection Circuit

(3) How to use it

As can be seen from (2) above, “0.25 µA × the voltage for the wiring resistance of a thermocouple” is added to the temperature measured by a thermocouple (electromotive force), because current of 0.25 µA is flowing to the thermocouple side. That is how wiring resistance increases with a longer wire of a thermocouple, which pushes up measurement errors derived from the detection current for breakage of wire. In case of 6mφ radiometer space chamber, the thermocouple wiring resistance to the facility side is 20Ω, which denotes exceeded measurement accuracy of the logger (within ±1℃) when the thermocouple wiring resistance to the TS side goes over 80Ω.

Therefore, it is recommended to follow the instructions in Table 3-17 when using the wire breakage detection function.

Table 3-17 Recommended Usage Instructions for Wire Breakage Detection Function (1/2)

thermocouple wiring resistance for the TS side	80Ω or less	over 80Ω	
		temperature monitor channel	temperature control channel
ON/OFF of wire breakage detection function	It can be either turned on or off.	It is recommended to be turned off.	It is to be turned on.
measurement accuracy	-200℃ ～ -130℃: Ask the facility staff because measurement errors differ depending on temperature (nonlinear.) -130℃ ～ : within ±1℃	-200℃ ～ -130℃: Ask the facility staff because measurement errors differ depending on temperature (nonlinear.) -130℃ ～ : within ±1℃	The following accuracy can be assured if system calibration is executed in advance using the wiring resistance of a thermocouple. -200℃ ～ -130℃: Ask the facility staff because measurement errors differ depending on temperature (nonlinear.) -130℃ ～ : within ±1℃
screen display for wire breakage	When wire breakage detection function is on： The data display area shows “breaking of wire.” When wire breakage detection function is off： The graph display of temperature becomes unstable.	In the data display area and the graph display area; ・The graph display of temperature becomes unstable. ・Abnormal values are displayed.	The data display area shows “breaking of wire.”

Table 3-17　Recommended Usage Instructions for Wire Breakage Detection Function (2/2)

thermocouple wiring resistance for the TS side	80Ω or less	over 80Ω	
		temperature monitor channel	temperature control channel
how to use the function (including restrictions, cautions, etc.)	With no wire breakage, normal temperature measurement is possible regardless of the wiring resistance of a thermocouple.	・With no wire breakage, normal temperature measurement is possible regardless of the wiring resistance of a thermocouple. ・When unstable temperatures or abnormal values are indicated, it is possible to check the existence of wire breakage by temporarily turning on the wire breakage detection function.	・When wire breakage takes place, the heat source power supply maintains the preset values (e. g., 50% output, etc.) ・When system calibration is required to be executed by the facility staff prior to the installation of a TS into the chamber, that is subject to additional charge to cover calibration on about 30 channels a day in the chamber. Re-execution of system calibration will be necessary after the test to restore the facility to the pre-test state (which costs the same amount of charge as above.) Users are to prepare a list of channels to be calibrated and thermocouple wires with the equivalent resistance as of those used for the test in advance.

3.3.6.6. Cautions

The data input device, the data gathering device, and the data processing device have their power supplied from the uninterruptible power supply. When power failure takes place, take measures, e. g., normal termination operation, etc., within the operation time (10 minutes) of the uninterruptible power supply system.

3.3.7. Utility Facilities

3.3.7.1. Clean Booth I/F

(1) General operation procedure

The outline flow of executing an optical performance confirmation test on a TS in the clean booth while mounted on the moving dolly is shown in Figure 3-37. It is to be noted that in the procedure of carrying the moving dolly into the vacuum vessel, when its ducts have to be removed, the clean booth cannot maintain the cleanliness of ISO5[ISO14644] (class M3.5, equivalent of class 100 [FED-STD-209E].)

(2) I/F inside clean booth

The effective test area (volume) in the clean booth is 3,500 mm (width) × 5,000 mm (depth) × 2,110 mm (height, with a clearance of 100 mm from the thermohydrometer.) (cf. Figure 3-38.)

(3) Required time for achieving ISO5 [ISO14644] (class M3.5, equivalent of class 100 [FED-STD-209E])

It takes about thirty minutes to establish an ISO5 [ISO14644] (class M3.5, equivalent of class 100 [FED-STD-209E]) environment in the clean booth with no personnel inside.

(4) Max. capacity in the room

The clean booth can hold up to three people.

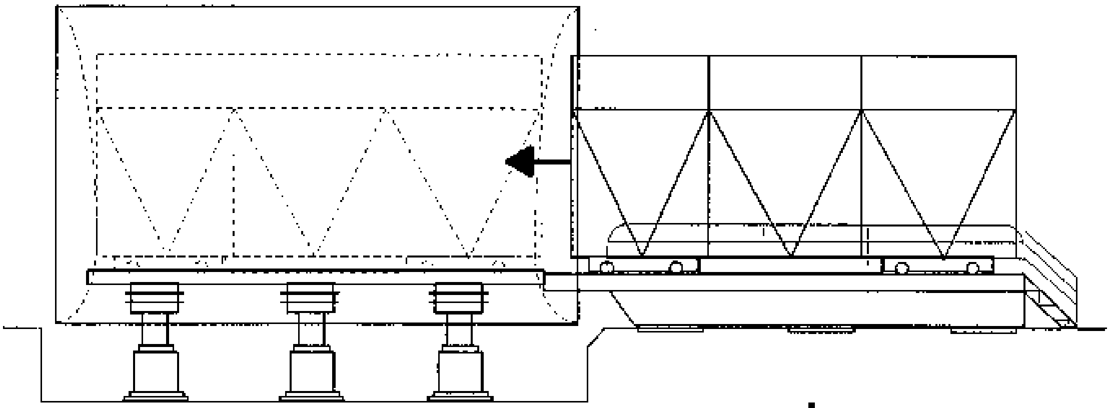
(5) Monitoring of temperature/humidity

The temperature and humidity data inside the clean booth can be monitored and checked during the operation of the clean booth from its operation console via three points for each of temperature and humidity. Among the three points, the temperature and humidity of the one in the center are recorded and saved in the data acquisition system.

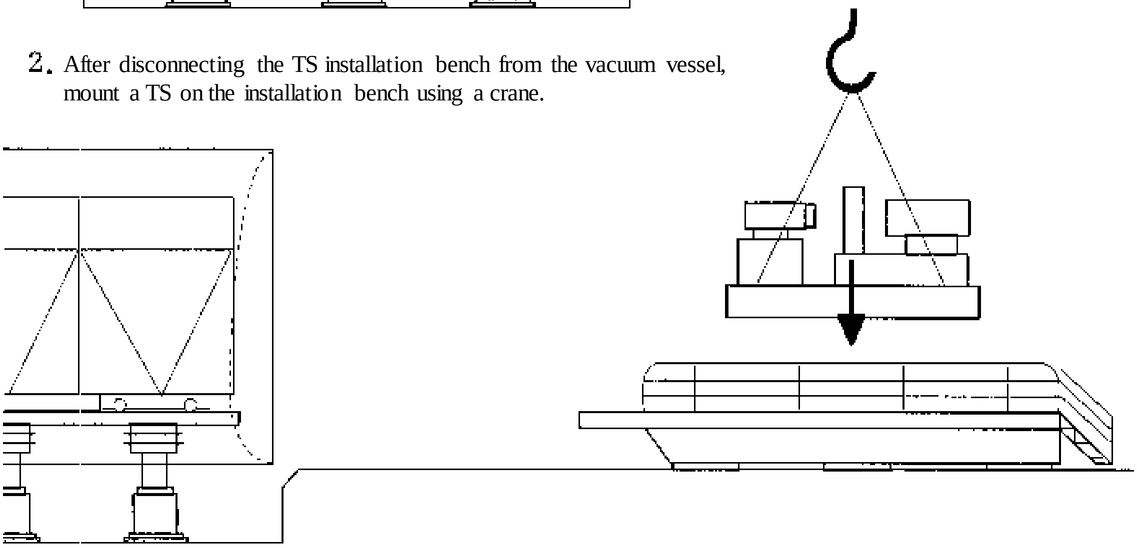
(6) Configuration of related equipment

The usage of the clean booth requires air-conditioning ducts to be configured, and therefore limits the usable range for setting test-related equipment next to the chamber as shown in Figure 3-39.

1. After connecting the TS installation bench to the vacuum vessel, move the clean booth into the vacuum vessel.



2. After disconnecting the TS installation bench from the vacuum vessel, mount a TS on the installation bench using a crane.



3. After connecting the TS installation bench to the vacuum vessel again, move the clean booth onto the installation bench.

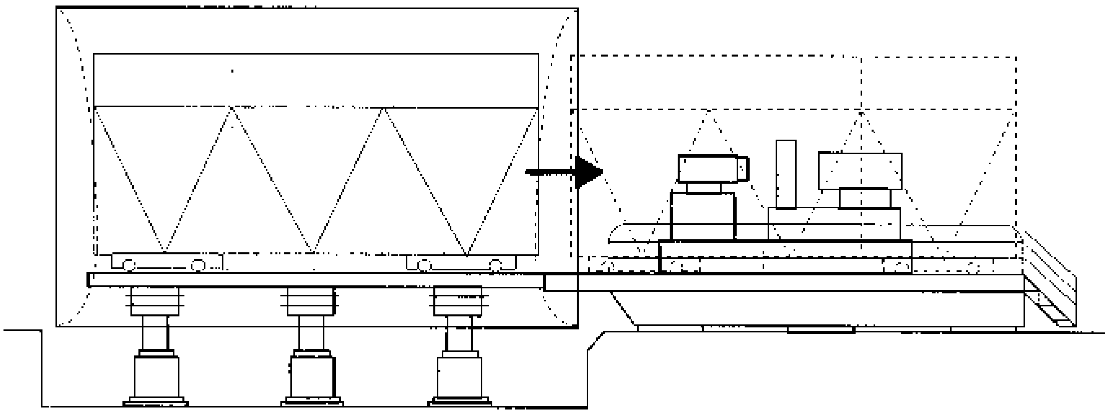


Figure 3-37 Outline Flow of Clean Booth Operation

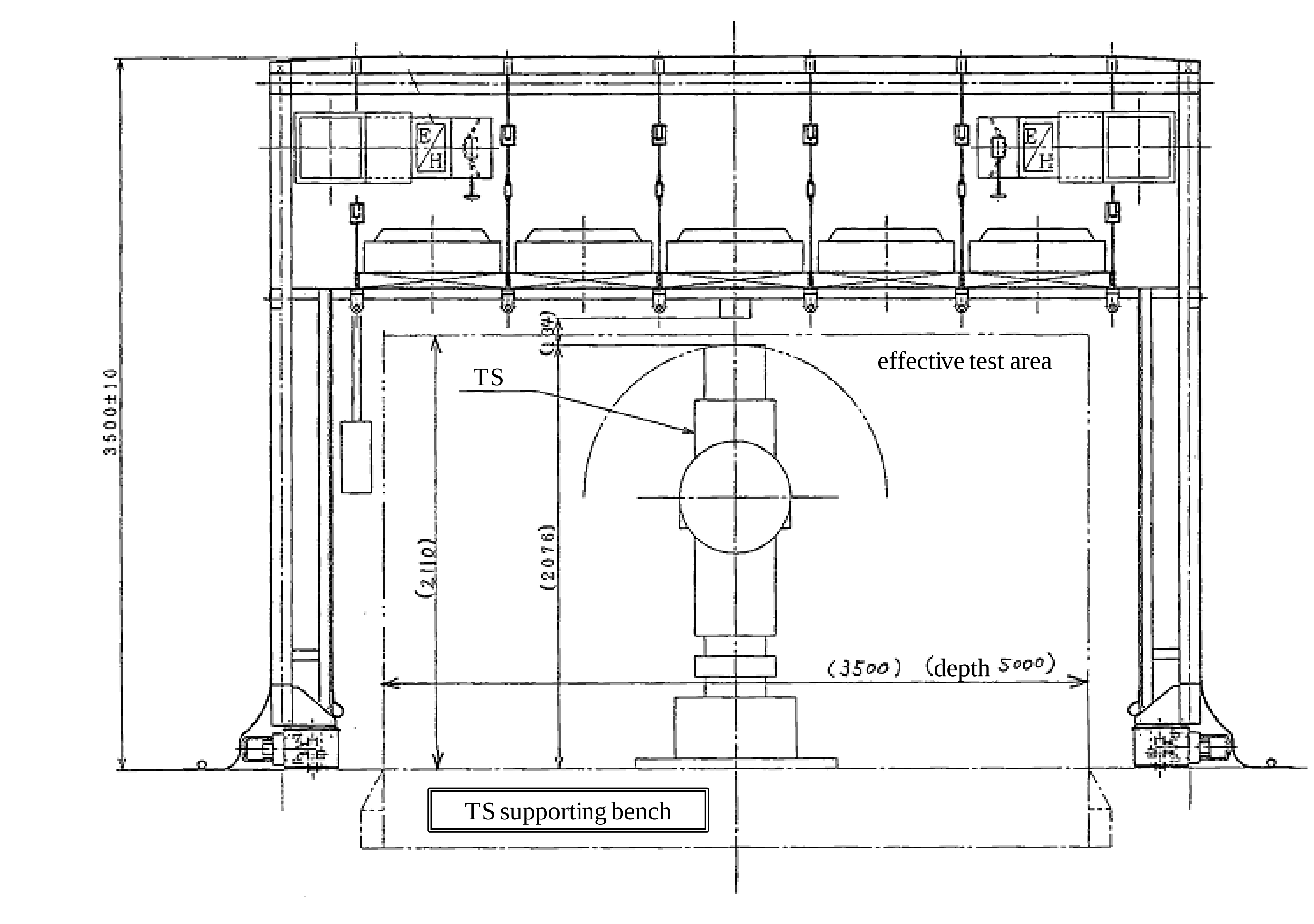
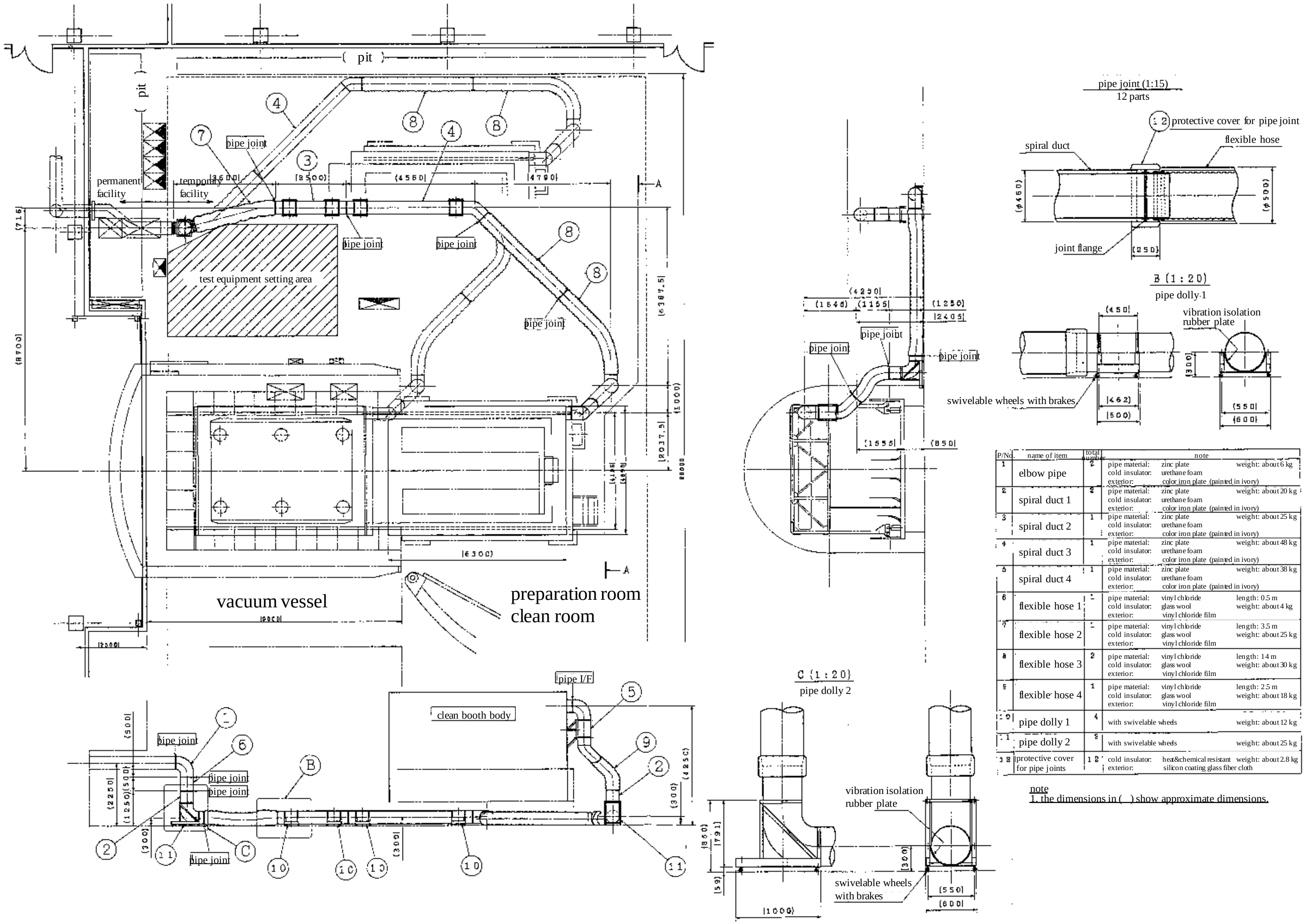


Figure 3-38 Height inside Clean Booth



P/No.	name of item	total number	note
1	elbow pipe	2	pipe material: zinc plate, weight: about 6 kg; cold insulator: urethane foam; exterior: color iron plate (painted in ivory)
2	spiral duct 1	2	pipe material: zinc plate, weight: about 20 kg; cold insulator: urethane foam; exterior: color iron plate (painted in ivory)
3	spiral duct 2	1	pipe material: zinc plate, weight: about 25 kg; cold insulator: urethane foam; exterior: color iron plate (painted in ivory)
4	spiral duct 3	1	pipe material: zinc plate, weight: about 48 kg; cold insulator: urethane foam; exterior: color iron plate (painted in ivory)
5	spiral duct 4	1	pipe material: zinc plate, weight: about 38 kg; cold insulator: urethane foam; exterior: color iron plate (painted in ivory)
6	flexible hose 1	1	pipe material: vinyl chloride, length: 0.5 m; cold insulator: glass wool, weight: about 4 kg; exterior: vinyl chloride film
7	flexible hose 2	1	pipe material: vinyl chloride, length: 3.5 m; cold insulator: glass wool, weight: about 25 kg; exterior: vinyl chloride film
8	flexible hose 3	2	pipe material: vinyl chloride, length: 14 m; cold insulator: glass wool, weight: about 30 kg; exterior: vinyl chloride film
9	flexible hose 4	1	pipe material: vinyl chloride, length: 2.5 m; cold insulator: glass wool, weight: about 18 kg; exterior: vinyl chloride film
10	pipe dolly 1	4	with swivelable wheels, weight: about 12 kg
11	pipe dolly 2	[illegible]	with swivelable wheels, weight: about 25 kg
12	protective cover for pipe joints	12	cold insulator: heat&chemical resistant, weight: about 2.8 kg; exterior: silicon coating glass fiber cloth

note
1. the dimensions in ( ) show approximate dimensions.

Figure 3-39 Configuration of Clean Booth Ducts

3.4. Facility Belongings

This facility is equipped with the following connectors, etc., necessary for obtaining data during a test, which can be rented out for users. The procedures for renting and returning the items are shown under the table.

Table 3-18 List of Facility Belongings

item	usage purpose	model #	owned qty
connector (plug)	for signals, EP, IR power supplies, and RTDs	MS3106B18-1S	–
		MS3106B22-23S	–
		MS3106B32-17S	–
	for thermocouples	AFD56-16-26SN	–
		JA3106B24-J28SC	–
socket contact*	for thermocouples	0603-34-2039	–
		105372	–
		NM-104-845#1	–
		NM-104-845#2	–
calorimeter	for radiation intensity measurement	ST4356A	30
T-QCM	for contamination monitoring	MK-10 sensor MODEL1900 processor MODEL1800 temperature controller	4 sets

* Socket contacts (for thermocouples) are crimp-type, and are therefore not reusable. Users are to prepare them by themselves. In case they cannot be procured on time for the schedule, those equipped in the facility are also available. In that case, make sure to return equivalent items later.

Note) Users are also to prepare plugs by themselves as much as possible. In case they cannot be procured on time for the schedule, those equipped in the facility are also available. In that case, users are to pull out the pins of thermocouple plugs, or clean solder off other equipment before returning them.

[Procedures for Renting and Returning Items]

(1) When renting items, users are to fill in the acknowledgement form of rent (prepared by the operation company of the facility) with the names, quantity, etc., of necessary items.

(2) The items are to be returned as soon as the tenancy is over. Expendables (e. g., socket contacts, etc.) are to be replaced by the same number of the same new items.

(3) The items with solder applied (e. g., connectors, etc.), if any, are to be returned after wiping off the solder clearly, or to be refilled with the same number of the same new items.

(4) The operation company of the facility will explain anything not yet clear to users concerning the procedures for renting and returning items.

3.5. Building I/F

(1) Preparation room

This room, where the chamber is located, is used as a working area for users to carry out preparatory work and tests.

(a) Gradient of floor and load capacity

The floor of the preparation room has a gradient of 3/1000 or less because the TS installation device moves on it. The floor therefore has a specified load capacity, which is 9.8 kPa for widely-spread load and 7.85 MPa (= compressive strength of floor coating material. The compressive strength of concrete (for temporary load) is 23.8 MPa) for concentrated load (e. g., casters of a bench, etc.) The floor requires prior curing even for an item weighing less than the specified load capacity if it has any possibility of damaging the floor.

(b) Hand-pallet truck

A hand-pallet truck can be used for moving heavy items in the preparation room. There are large-size and small-size hand-pallet trucks. The former is the same as the TS installation dolly (cf. section 2.2.2), with the same dimensions and capacity. The basic descriptions of the smaller hand-palled truck are shown below.

Table 3-19 Basic Descriptions of Hand-pallet Truck

	hand-pallet truck (small)
dimensions	1,230W × 1,600L × 193H
capacity	2,400 kg

When moving a TS, etc., using the larger hand-pallet truck, it is convenient to use the satellite mounting bench (large) (cf. Figure 3-40.) Its mass and the maximum load mass are 2,100 kg and 4,000 kg, respectively.

(c) Temperature/humidity monitoring

The temperature and humidity in the preparation room can be displayed on a portable monitor.

(d) Particles (cleanliness)

Particles are being counted by the dust counter located in the preparation room.

(e) Max. capacity in the room

The preparation room can hold up to 15 people.

(2) Measurement and control room

Users carry in check-out devices, etc., into this room, for performing data analysis, etc.

(3) Distribution boards for users

The installation sites and usage purposes of the distribution boards and plug socket boards necessary for performing a test are shown in Table 3-20. Each distribution board has a plug socket board at the lower part of itself. In addition to that, LS-1B and 1C each has a surface plug socket board (A.) Refer to Figure 3-41 for their locations. The WBD diagram of distribution boards is shown in Figure 3-42. The specifications of the plug socket board at the lower part of a distribution board and the surface plug socket board (A) (configuration of sockets) are shown in Figure 3-43.

Since the distribution boards are also connected to the emergency power supply system, they can all gain power from the private power generator in the power building in case the commercial power supply is interrupted. It takes about 10 minutes before the private power generator finally gets to supply power, which then starts supplying power to the distribution boards in the order of priority. Likewise, power failure takes place for about 10 minutes at the time of power restoration by the commercial power supply.

Table 3-20 List of Distribution Boards for Users

distribution board #	installation site	usage purpose
LS-1B	preparation room	for sockets and devices
LS-1C	preparation room	for sockets and devices
LS-1E	fore-room	for sockets and devices
LS-1I	measurement and control room	for sockets and devices

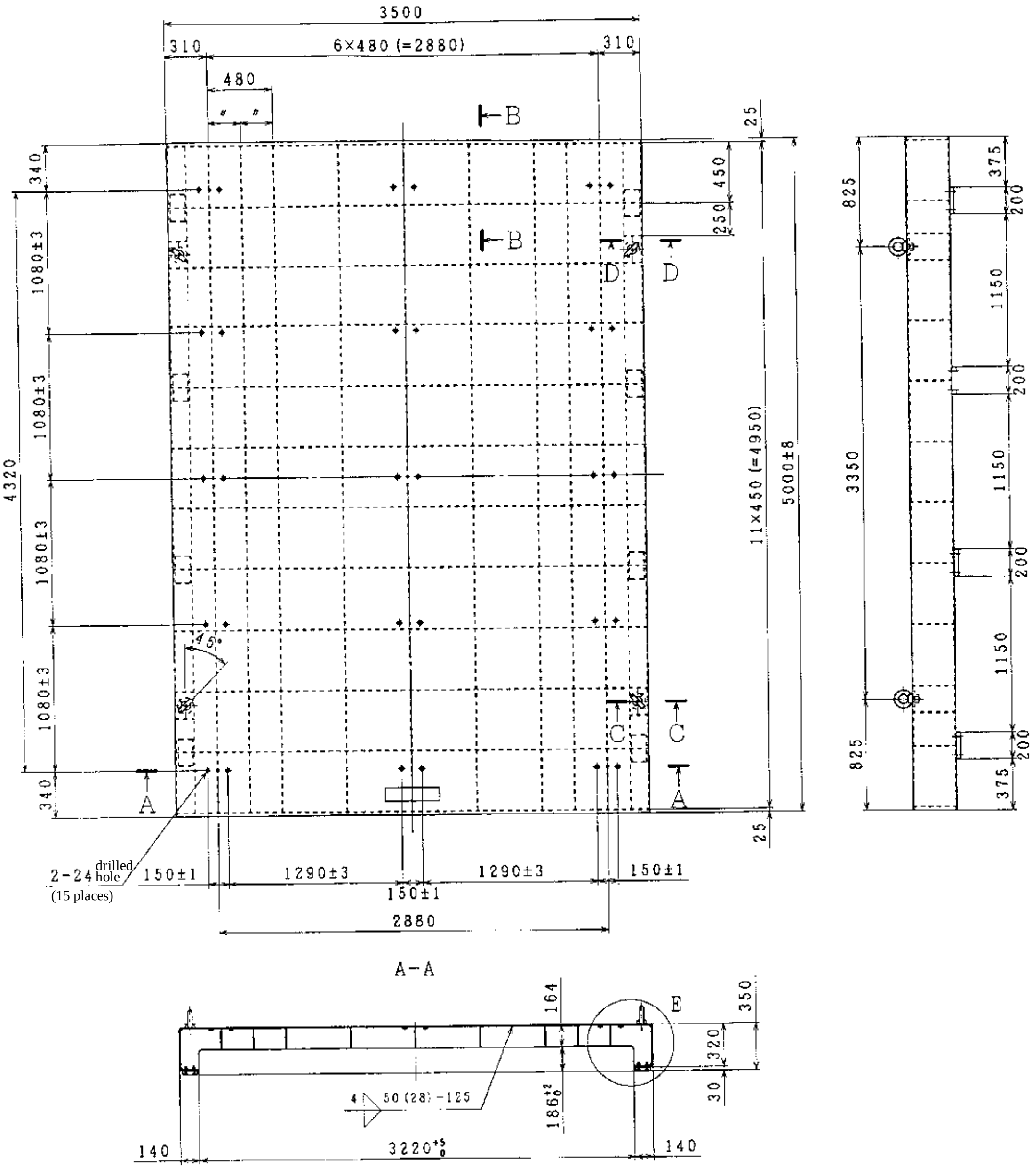


Figure 3-40 Mounting Bench (Large)

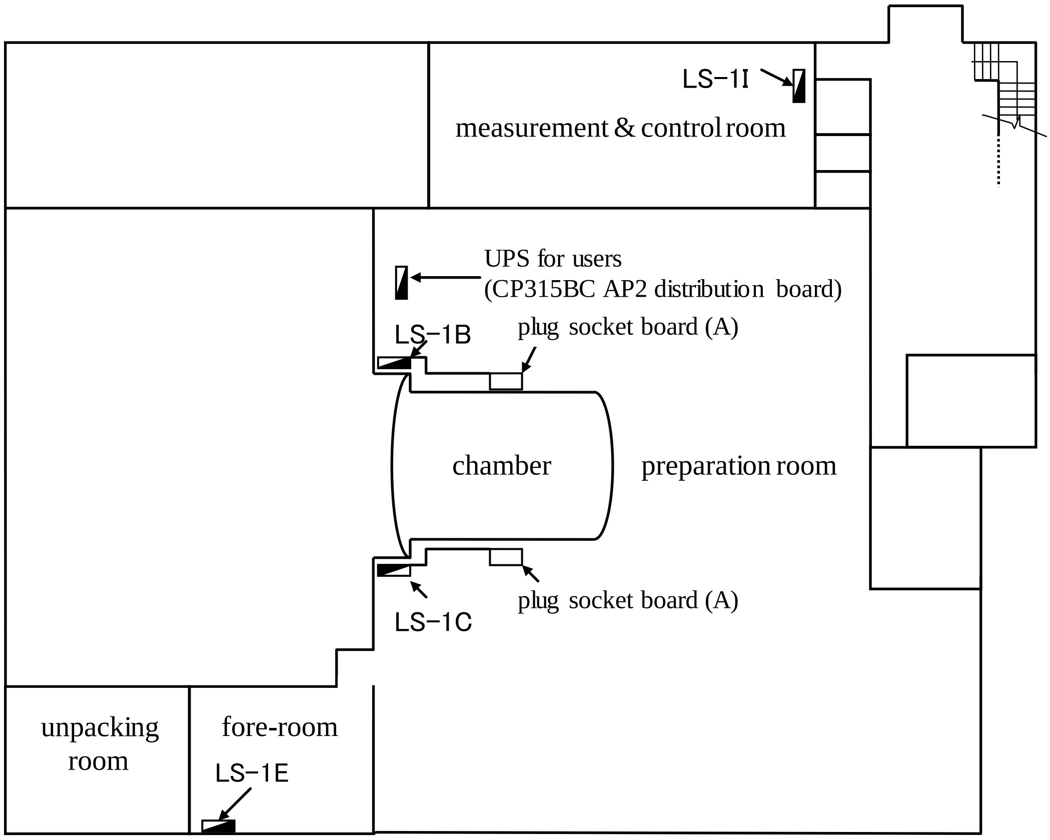


Figure 3-41 Configuration of Distribution Boards/Plug Socket Boards

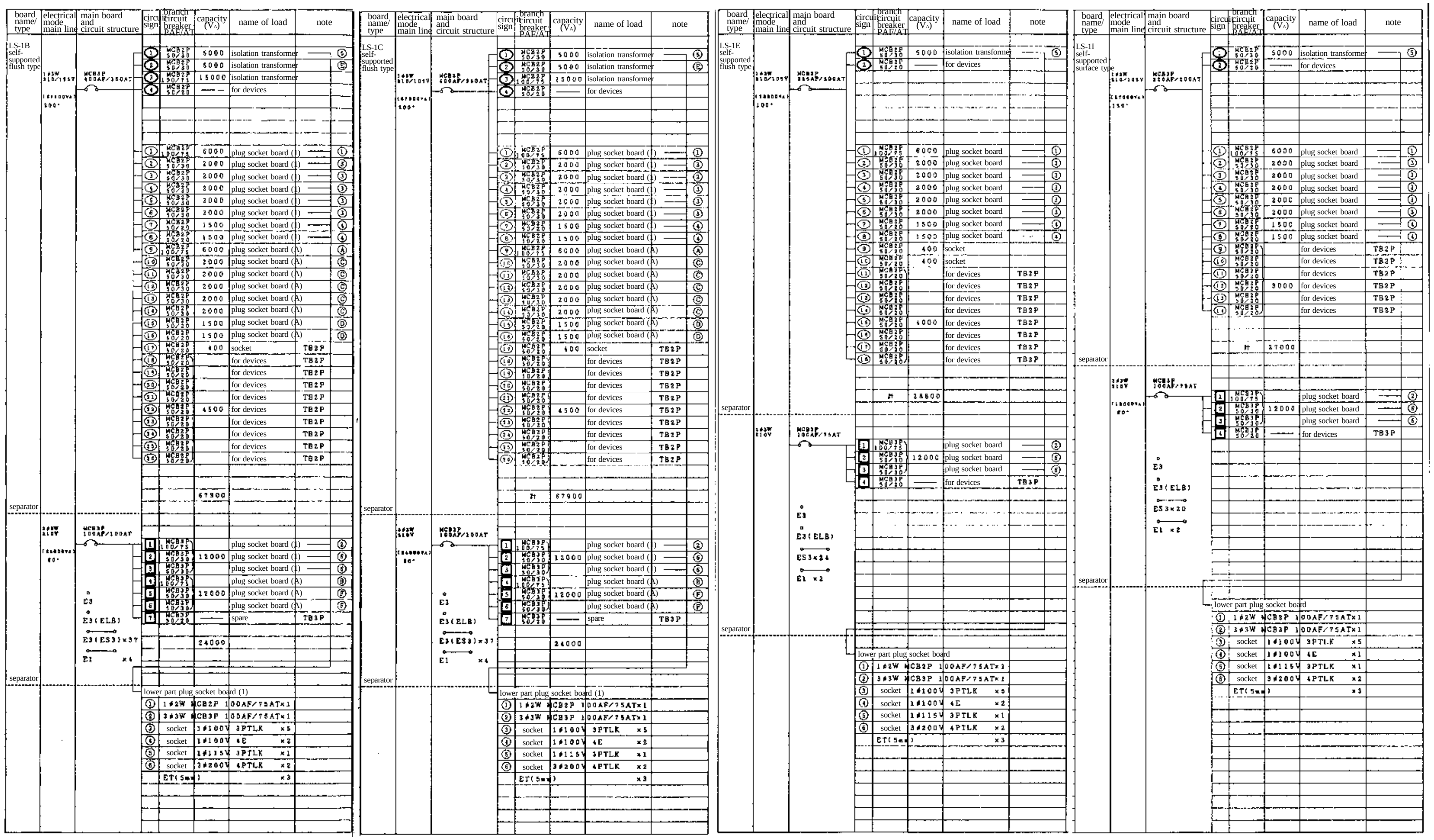
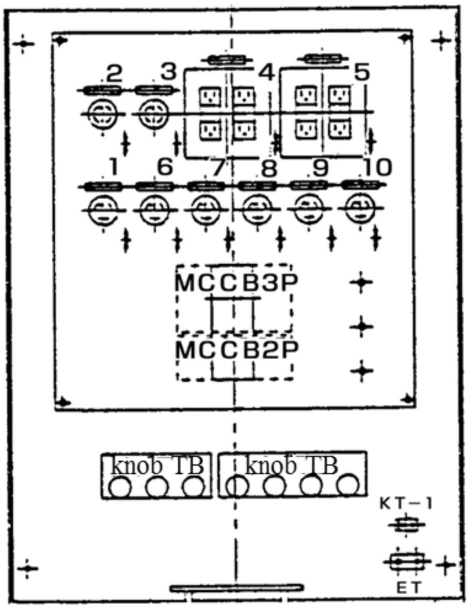


Figure 3-42 WBD Diagram of Distribution Boards

Configuration of Sockets
3 φ 200V 3P30A × 2
1 φ 115V 2P30A × 1
1 φ 100V 2P30A × 5
1 φ 100V 2P15A ground double outlet × 4
3 φ 200V 3P100AF/75AT MCCB × 1 (connectors are on knob terminal block)
1 φ 100V 2P100AF/75AT MCCB × 1 (connectors are on knob terminal block)
GND terminal × 3



Configuration of Sockets
3 φ 200V 3P30A × 2
1 φ 115V 2P30A × 1
1 φ 100V 2P30A × 5
1 φ 100V 2P15A ground double outlet × 4
3 φ 200V 3P100AF/75AT MCCB × 1
1 φ 100V 2P100AF/75AT MCCB × 1
1 φ 220V 2P 50AF/50AT MCCB × 2
GND terminal × 3

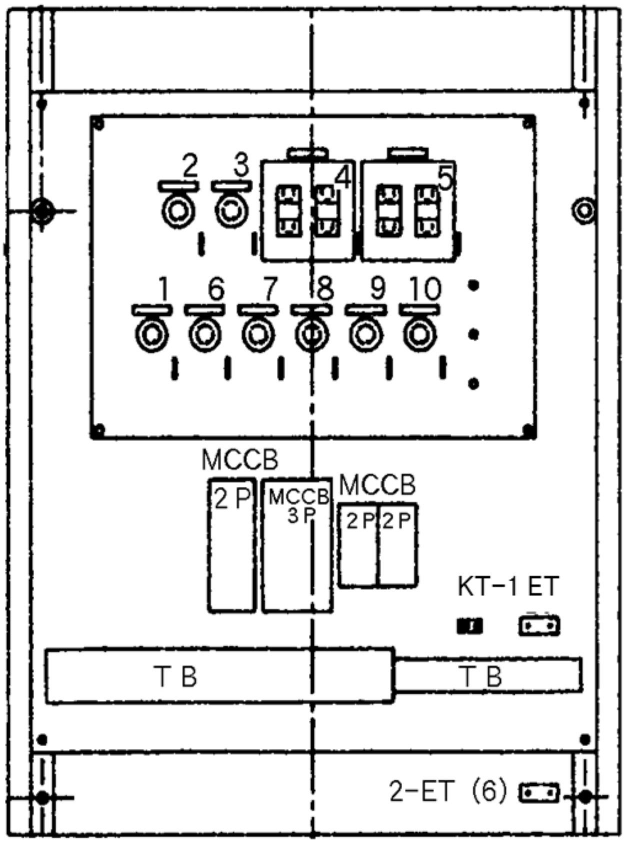


Figure 3-43 Specifications of Socket at Lower Part of Distribution Board and Plug Socket Board (A)

(4) Cranes

There are cranes between the unpacking room and the fore-room, and in the preparation room, which can be used for carrying in a TS, etc. When using them, they are to be operated only by qualified people, who are always to fill in the specified record form with the track record of use. There is a rail switch mechanism between the unpacking room and the fore-room crane, which allows the transportation of items with the crane between the two rooms with the shutter open. The specifications of the cranes are shown in Table 3-21. Each crane is oil-drip proofed, but a TS is to be protected by a cover, etc., for precaution's sake. Refer to Figure 3-45 for the movable range of each crane. The cranes require about ten seconds to be ready for operation after the "on" button on the pendant switch is pressed due to the installed inverter, while there is a little time lag before completely stopping after the "stop" button is pressed (same with the case of their activation.)

The hook is to be wound up to the limit after using the crane.

Table 3-21 Specification of Cranes

installation site	unpacking room ~ fore-room	preparation room
type	monorail hoist type 4.8t	doublerail hoist type 4.8t
rated load	4.8t	4.8t
lifting height	11.0m (below hook: 10.71m)	13.6m (below hook: 13.54m)
hoist speed (Min/max)	0.4/4.0 (m/min)	0.4/4.0 (m/min)
traverse speed (Min/max)	1.25/12.5 (m/min)	1.25/12.5 (m/min)
travel speed (Min/max)	2/20 (m/min)	2/20 (m/min)
operation method	press button on the floor	press button on the floor

Note 1) The speed can be changed by pressing the buttons for low and high speeds.

Note 2) The low speed at the first step is changable. The speed range, however, is within 1/10 of the top speed.

(5) Unpacking room

The shutter facing the outside has a slight opening, through which rain, etc., can enter the room at the occasion of typhoon, etc. Therefore, no jigs or measurement instruments are to be placed near the shutter.

(6) UPS for users

There is a UPS available to users in the preparation room. Contact the facility operation company in advance if it is planned to be used.

(a) Location

Refer to Figure 3-41.

(b) Specifications

① Max. total output capacity: 15.0 kVA

② Backup duration: 10 min or longer

③ Output rating/wiring number

Table 3-22 Specification of UPS

output rating		wiring # on branch power board
AC200V three-phase three-wire 50Hz	total: 4 circuits	U1, V1, W1
		U2, V2, W2
		U3, V3, W3
		U4, V4, W4
AC200V single-phase two-wire 50Hz	total: 3 circuits	U5, V5
		V6, W6
		W7, U7
AC100V single-phase two-wire 50Hz	total: 3 circuits	U8, N8
		V9, N9
		W10, N10

* Wiring is to be performed after checking the wiring numbers shown on the branch power board at site.

(c) Others

A circuit diagram of the branch power board is shown in Figure 3-44.

The total load from the equipment mounted by users is to be 75A or less.

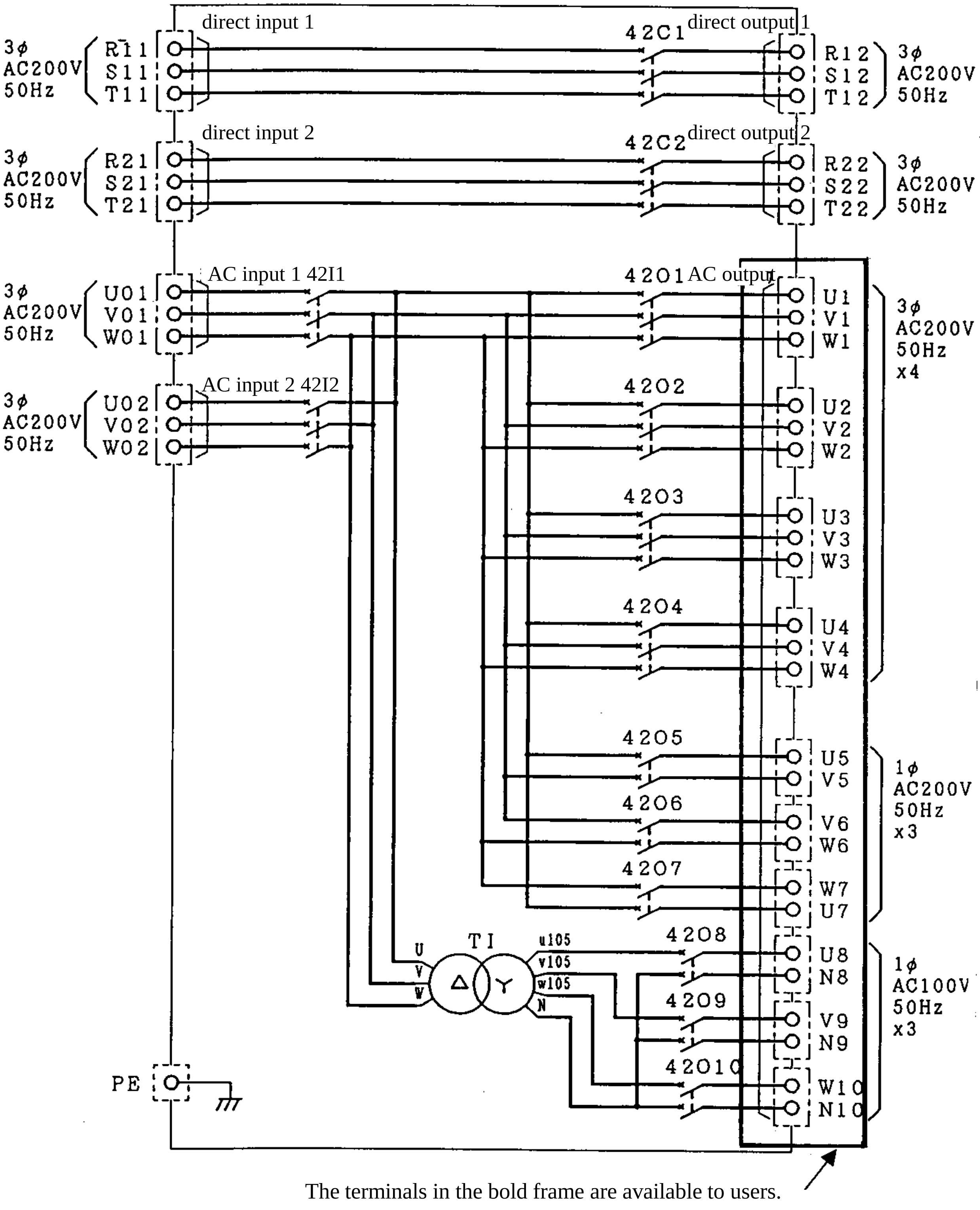
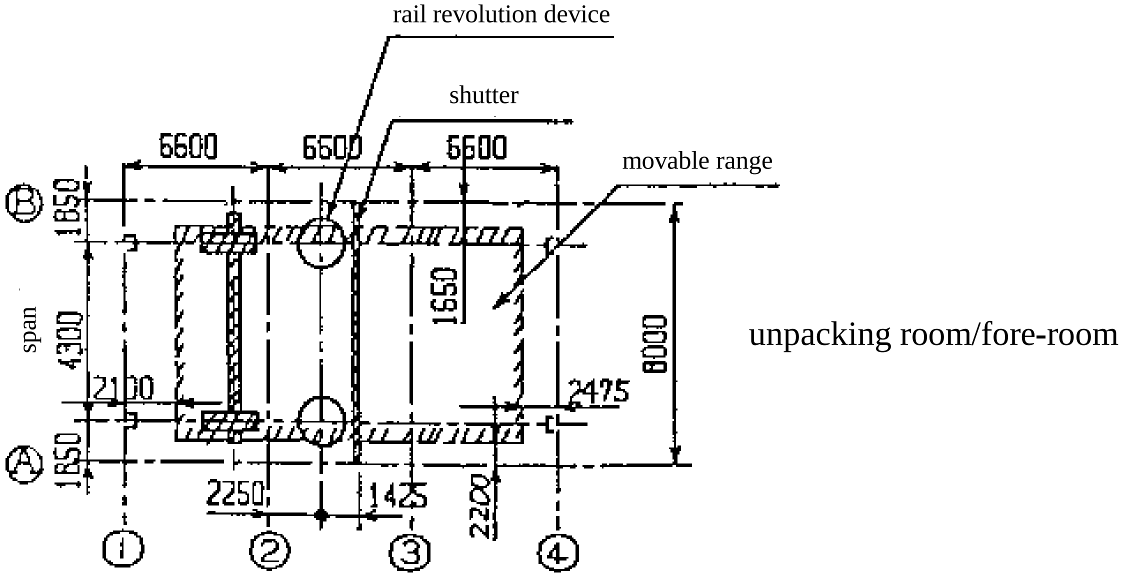


Figure 3-44 Circuit Diagram of Branch Power Board for Users



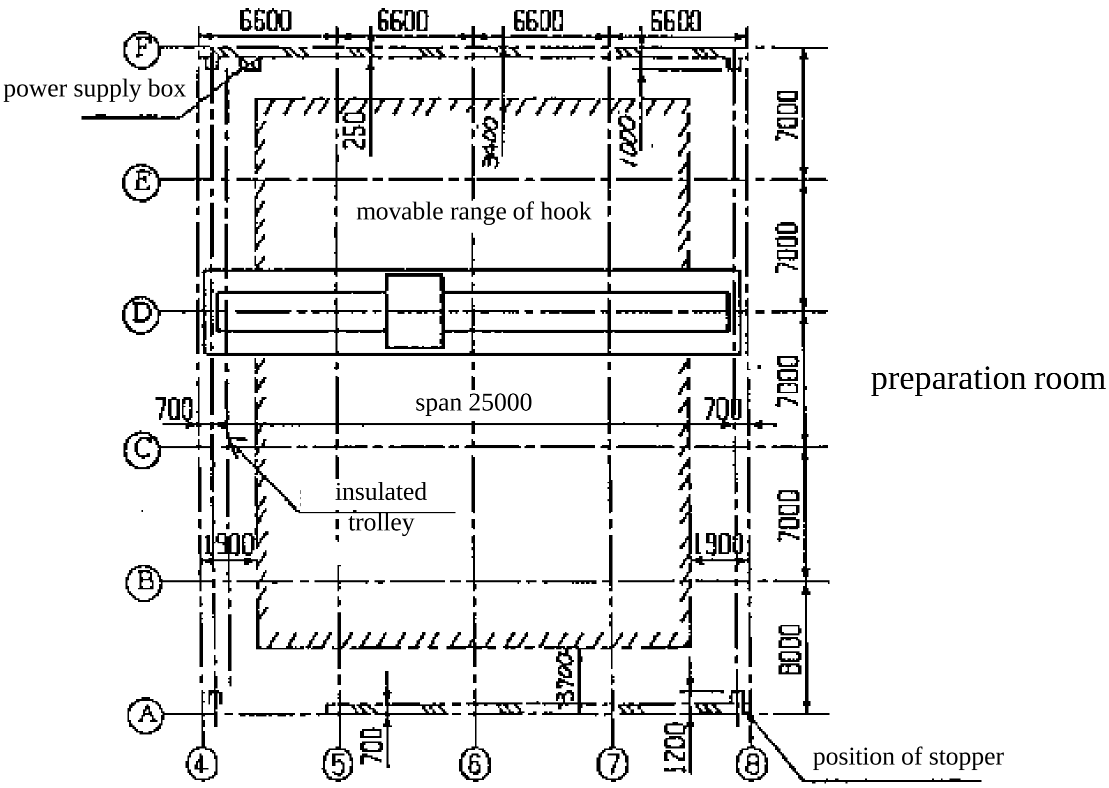


Figure 3-45 Movable Range of Crane in Each Room

(7) Contamination control

(a) The requirements for optical sensors are becoming more and more demanding compared to general TSs. That is why this facility executes more strict contamination control than other facilities in Tsukuba Space Center. Precisely, the following measures are being taken.

① Particulate contamination is controlled abiding by ISO7 [ISO14644] (class M5.5, equivalent of class 10,000 [FED-STD-209E].）

② Molecular contamination is prevented by refraining from using oil as the lubricant for the sliding parts of equipment used in the preparation room as much as possible; otherwise, the oil-applied parts are tightly sealed.

(b) When testing an optical sensor that calls for especially demanding cleanliness requirements, the clean booth will help establishing the ISO5 [ISO14644] (class M3.5, class 100 [FED-STD-209E]） environment.

(c) The preparation room and the clean booth are designed to retain cleanliness for their Max. capacities of fifteen and three people, respectively. The number of people exceeding the capacities may fail to satisfy the cleanliness. Never enter or leave the preparation room without clearly indicating the entering/leaving state on the management board at the entry/exit.

(d) NVR plates for detecting non-volatile residue are set in the chamber all through a test to check for contamination on a TS and the facilities. Refer to Figure 3-46 for the installation sites of NVR plates. It takes about a week to complete the analysis on the amount of contamination, and users may be required to clean inside the chamber or perform a verification test (including analysis) at users' expense when the analysis results suggest the existence of contamination on the facilities (viz. the amount of NVR on work floor: 1.5 mg/0.1m^2 or more*). It takes about two weeks to clean inside the chamber and complete a verification test.

* Policy for contamination measurement in thermal vacuum tests (GCT-2011023)

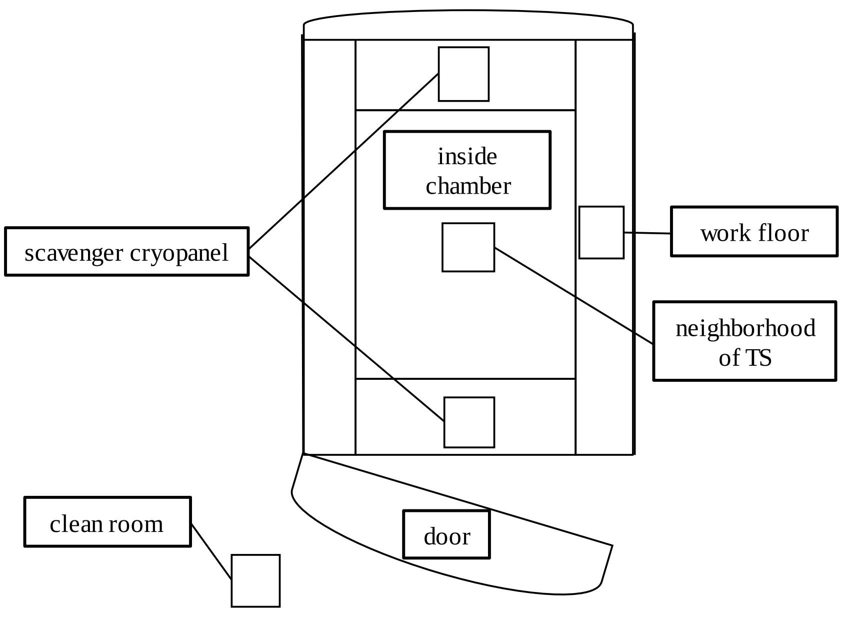


Figure 3-46 Diagram of Installation Sites for NVR Plates

(e) General cautions in the clean room

The rules shown below are especially crucial for users to follow when using the clean room.

① Clean garment

Users are to wear one of the following clean garments depending on the cleanliness requirements of a TS.

ISO5 [ISO14644] (class M3.5, equivalent of class 100 [FED-STD-209E]): overall, hood, mask, boots

ISO7 [ISO14644] (class M5.5, equivalent of class 10,000 [FED-STD-209E]): overall, hood, boots (or shoes, shoes cover.)

ISO8 [ISO14644] (class M6.5, equivalent of class 100,000 [FED-STD-209E]): overall (the kind same as those used in other clean rooms is acceptable), cap, short boots.

When coping with contamination-sensitive surfaces, wear a pair of gloves in addition to the items above.

For a test in a clean booth, a clean garment that meets class 100 requirements is to be prepared. For reference, some examples of clean garments (model numbers) used by the facility are shown below.

Overall: FB102C
Hood: FB405C
Boots: FE652C
Mask: FZ554C
Gloves: Cleanfast1000

manufactured by Toyo Lintfree Co.

* The clean garments used by facility-side personnels are the kinds to satisfy the cleanliness standards of both ISO5 and ISO7 [ISO14644.]

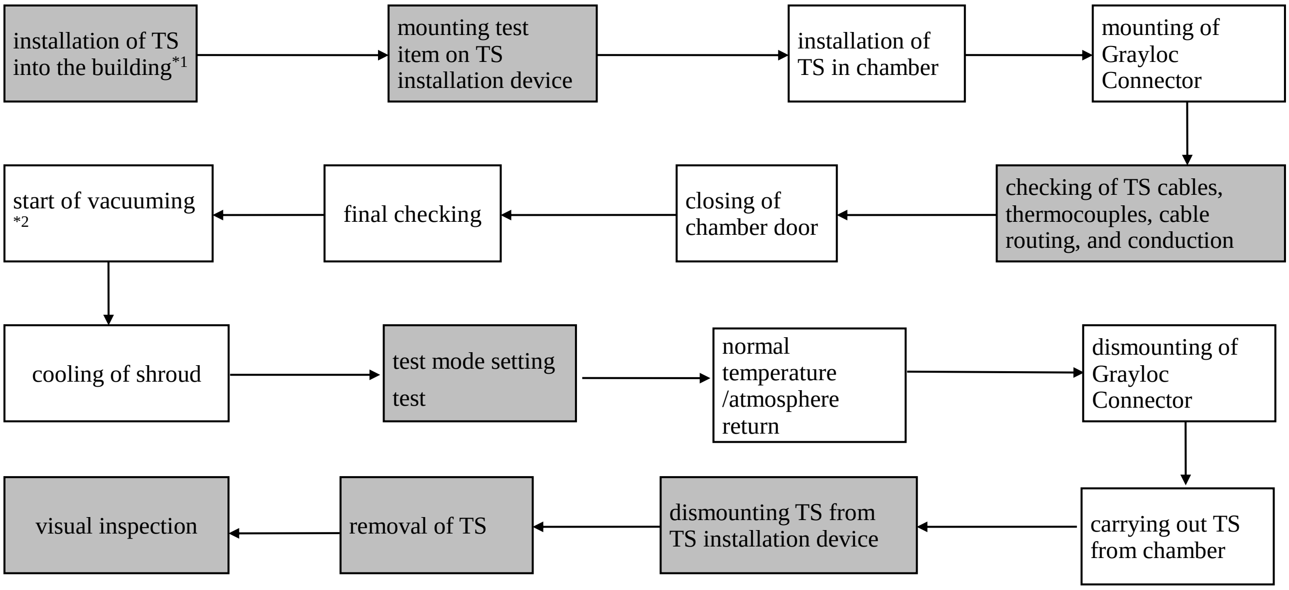
② Stationary articles

Refrain from bringing in paper into the preparation room to the extent possible. If not avoidable, choose dust-free paper. As a writing tool, use a ballpoint pen.

4. Execution of Tests

4.1. Test-related Work Procedure

Each work in the course of a test is executed based on the test implementation plan sheet presented by the TS side. The following Figure 4-1 shows a general flow of test-related work. (The hatched boxes show the work to be done by the TS side.)



*1 A TS is to be left in the fore-room for about 1 hour to wait for the recovery of cleanliness, before being carried into the preparation room.

*2 A test schedule is to be arranged the way low vacuuming starts at 13:00.

Figure 4-1 Test-related Work Flow

4.2. Test Procedure

4.2.1. General Description of Test

In this facility, tests are classified in two ways according to their purposes and methods. Each classification is described below. The selectable test methods are determined by test purposes. Refer to Table 4-1 for more details.

(1) Classification according to purposes

In this facility, environmental tests, e. g., (a) radiometer optical property tests, (b) IR radiation thermal balance/thermal vacuum tests, etc., can be performed. The general description of each environmental test is provided below. The environmental conditions of each test are described in Table 4-2.

(a) Radiometer optical property test

It is a test for checking the optical properties, etc., of a TS in the high vacuum and cryogenic temperature simulating outer space and in the atmospheric pressure and normal temperature.

(b) IR radiation thermal balance/thermal vacuum test

A thermal balance test confirms the thermal design, etc., of a TS in the high vacuum and cryogenic temperature that simulate outer space, while a thermal vacuum test confirms the environmental resistance of equipment mounted on a TS to the thermal environment in space, that is, high and low temperatures and the back-and-forth transition between them. IR lamps or heaters are used as the heat sources.

(2) Classification according to methods

The following three modes can be chosen as a testing method.

(a) Mode 1

In this mode, shrouds are started to be cooled after the chamber is vacuumed with a cryosorption pump to the level passed the discharge-hazardous range. That way a TS can be protected from excessive cooling. Thermal vacuum/balance tests are basically performed in this mode.

Note) There is a case in which the reached level is found to be in the discharge-hazardous range when a cryosorption pump is stopped after the shroud temperature is raised during atmosphere return, depending on the amount of outgas from a TS.

(b) Mode 2

In this mode, the chamber is started to be vacuumed with a cryosorption pump after the shroud is cooled down, for the purpose of performing thermal vacuum/balance tests. This mode enables the quick establishment of test conditions when there is no fear of damage on a TS caused by excessive cooling.

(c) Mode 3

This mode denotes a vacuum test in normal temperature. That is, only a vacuum state is established without cooling the shroud.

The correspondence between test purposes and test methods is shown below.

Table 4-1 Test Methods Corresponding to Test Purposes

test purpose	test method
radiometer optical property test	modes 1, 2, 3
IR radiation thermal vacuum/balance test	modes 1, 2

Table 4-2 Summary of Kinds of Tests and Environmental Conditions

kinds of tests environment	radiometer optical property test	IR radiation thermal balance/thermal vacuum test
(1) chamber pressure	1.33×10^{-4}Pa or less or atmospheric pressure	1.33×10^{-4}Pa or less
(2) IR intensity	20 kW (max)	20 kW (max)
(3) shroud temperature	100K or lower or 300K (normal temperature)	100K or lower

4.2.2. Standard Chamber Vacuum Curve, etc.

Figure 4-2 “Standard Chamber Vacuum Curve, etc.” shows a standard chamber vacuum curve in mode 1 (with no TS placed inside), a standard operation procedure, and a shroud temperature curve.

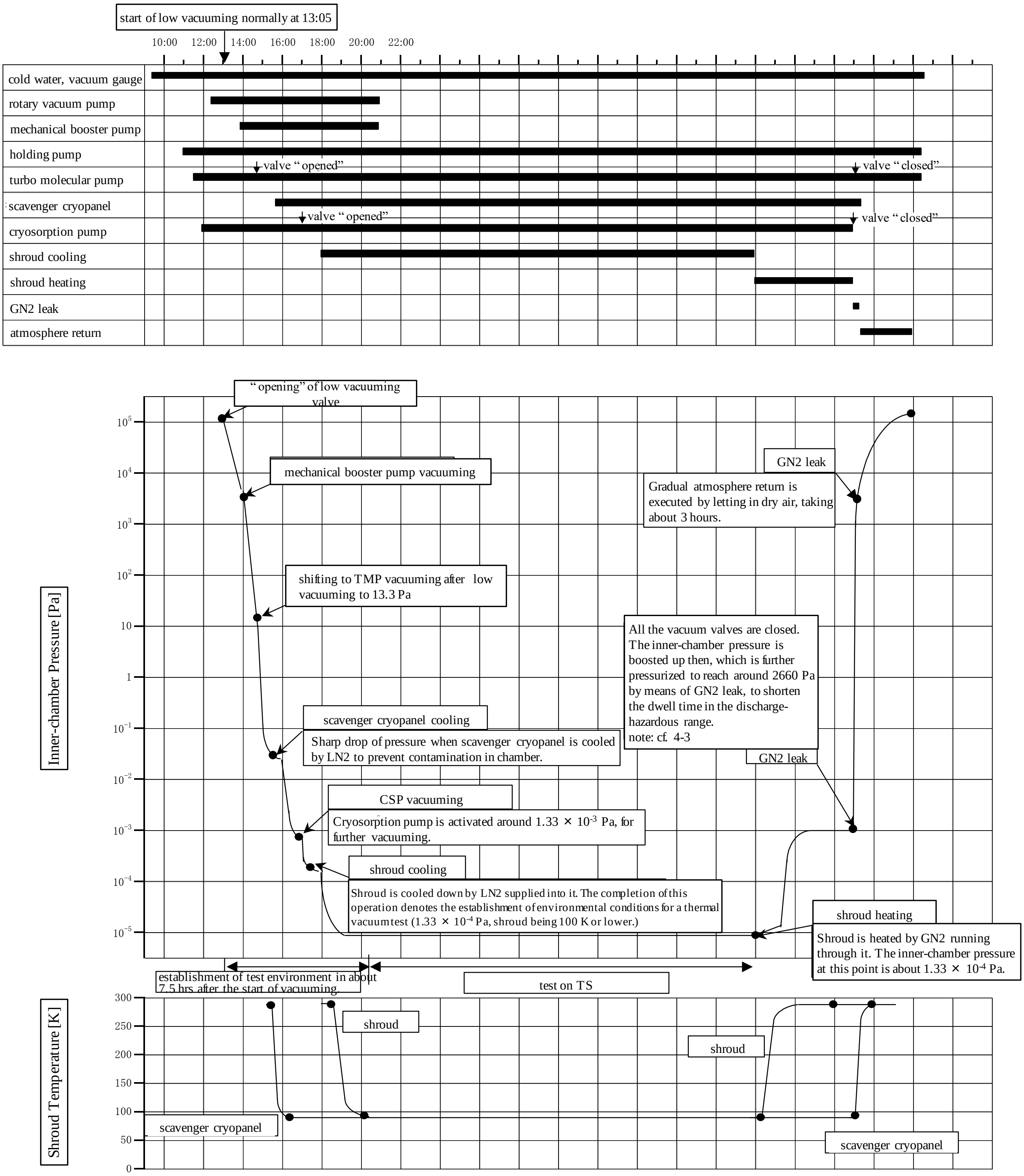


Figure 4-2 Vacuum Curve in Standard Chamber, etc.

4.3. Power Failure Protective Measures

The general flow of measures against momentary power interruption or power failure is shown in Figure 4-3.

(1) Momentary power interruption

(a) All the devices but the instrument air compressor in this facility are equipped with two-second momentary power interruption measures, which enables continued operation of vacuum pumps, etc., during power interruption of two seconds or shorter.

(b) Even though the instrument air compressor is aborted at the momentary power interruption of shorter than two seconds, it has no impact on test environments owing to the automatic backup by GN_2.

(2) Power failure

(a) In the power failure of two seconds or longer, all the mechanical vacuuming pumps, etc., are aborted, except for the cooler for shrouds and scavenger cryopanels. Then, it is to be determined whether to keep cooling the shrouds to avoid rapid pressure raise or stop cooling them by introducing GN_2, based on the power failure duration and the state of excessive cooling protection measures being taken for a TS. (Generally, continuous cooling of shrouds is chosen while waiting for power recovery.)

(b) When power failure lasts for two seconds or longer, the inner-chamber pressure rises up to the discharge-hazardous range (1.3×10^{-3}Pa) in about ten minutes. Therefore, discharge prevention measures, e. g., shifting a TS into a launch mode, etc., are to be taken as soon as power failure takes place.

(c) A 15 kVA UPS is prepared in the preparation room for users. It is recommended that the heater systems (e. g., power supply for IR heaters) wished to be heated during power failure or the checkout devices, etc., wished to be controlled and monitored during power failure be connected to the UPS in advance. Refer to section 3.5 for how to connect the UPS for users.

The power supply for IR heaters and checkout devices not connected to the UPS for users will be turned off during power failure.

(d) After about 10 minutes of power failure, the emergency power generator in the power building of Tsukuba Space Center starts supplying EP. Its pre-activation stand-by time and EP capacity vary depending on the state of its application by other facilities and equipment. Figure 4-4 shows the pressure transition inside the chamber during an assumed power failure of 20 minutes.

(e) The control device, data processing device, a remote setting PC for the power supply for IR heaters, communication system, and oximeter are connected to a UPS (uninterruptible power supply) which can supply power for 10 minutes or longer.

(f) In case power failure is not recovered for 10 minutes or longer, the saved data is to be stored in the external medium to make provision for hard disc failure due to the forced termination of the data acquisition system (measurement can be continued.)

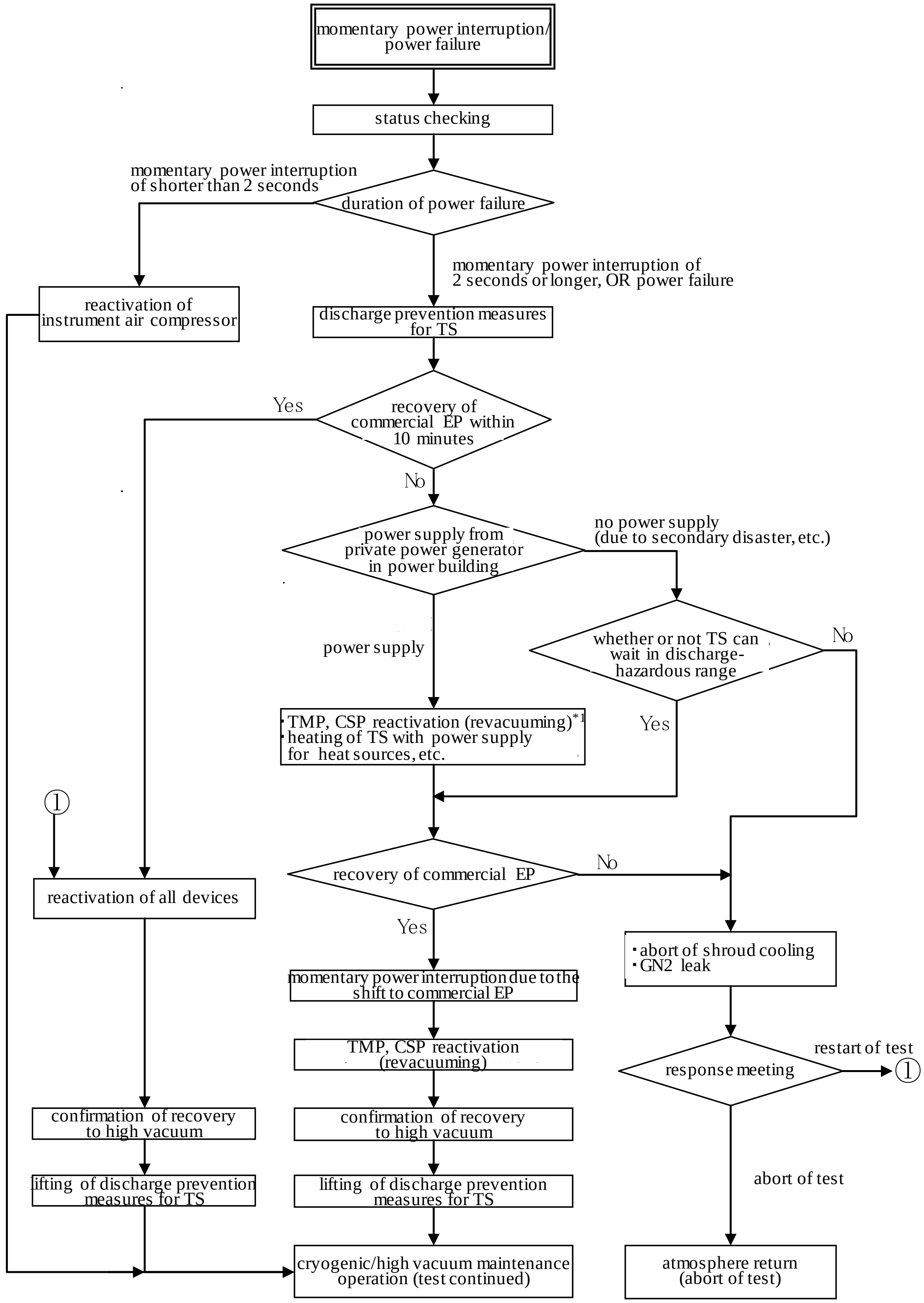
(g) The power supply from the emergency power generator in the power building of Tsukuba Space Center is finite. Therefore, unnecessary lights or devices are to be turned off while the emergency power generator is supplying EP, for the sake of saving EP to the extent possible.

(h) Once the emergency power generator in the power building of Tsukuba Space Center starts to supply EP, high vacuum operation (1×10^{-4}Pa or less) can be restarted with the help of cryosorption pumps (CSP) and turbo molecular pumps (TMP.)

(3) Power restoration

(a) A momentary power interruption takes place at the moment of power restoration when power supply shifts from the emergency power generator in the power building of Tsukuba Space Center to the regular power supply.

(b) High vacuum operation can be recovered in about thirty minutes after power restoration unless GN_2 or dry air was introduced into the chamber during power failure.



※1 TMP: turbo molecular pump
CSP: cryosorption pump

Figure 4-3 Standard Flow in Momentary Power Interruption and Power Failure

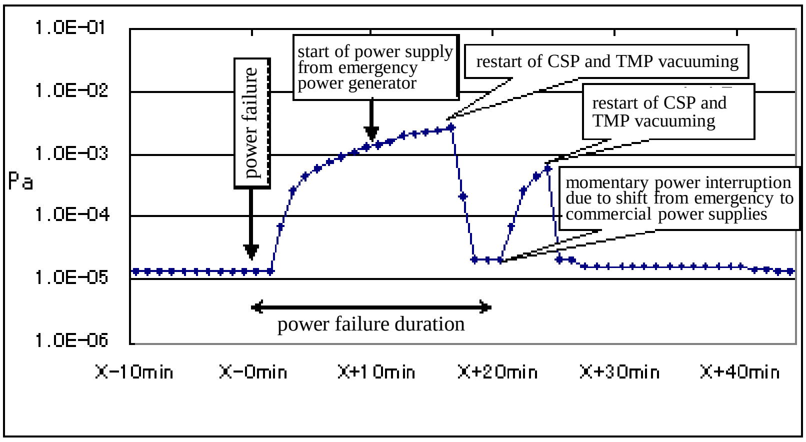


Figure 4-4 Inner-Chamber Pressure Transition during 20-minute Power Failure

4.4. Other Remarks

(1) Matters to be confirmed for test

The environment in the space chamber is the same as outer space in that it cannot be accessed promptly even when abnormalities are found on a TS. Bearing that in mind, the following matters are to be checked.

(a) Matters concerning chamber contamination

① Whether or not anything with high steam pressure or susceptibility to evaporation from heating is used in the chamber.

② Whether or not commercial products that are not made for the usage in space are being used. (Are there commercially available glues or adhesive tapes being used?)

③ Is the applied material less likely to generate outgas?

④ Whether or not a TS, jigs, etc., that are coated with paint have been put through enough baking.

(b) Matters concerning vacuum

① Whether or not there is gas leakage from gas-sealed equipment.

② Whether or not there is any chance that MLI might block vent holes (See if MLI does not cover the vent holes of tanks, etc.)

③ Whether or not MLI has vent holes, or one end of it is not fixed.

④ Whether or not there is a problem when inner or outer pressure is loaded.

⑤ Whether or not the vacuum seals on vacuum seal connectors have been closely inspected.

⑥ Whether or not leakage has been thoroughly inspected in case the vacuum vessel has any feed-through equipment (waveguide, tube, etc.)

(c) Harmful effects of low temperature

① Whether or not the material has low temperature brittleness that can cause a problem.

② Whether or not polymer material (rubber, etc.) is used in the parts that become cold.

③ Whether or not there is any item whose temperature won't go up readily during normal temperature atmosphere return. If there is any, it is to be checked if it is equipped with any mechanism to raise its temperature.

④ Whether or not a fluid is freeze-proven, if it is planned to be used.

(d) Matters concerning vacuum discharge

① Electric discharge is generally said to take place in the pressure range around 1.33×10^{-3} ~ 1.33×10^{4}Pa, where loading of high voltage may damange a TS due to electric discharge (cf. JERG-2-130-HB005 Handbook of Thermal Vacuum Test, section 3.7.1.)

② It is required that the electric-discharge-hazardous pressure range be determined by the TS side and reported to the facility-side personnel in advance.

③ It is to be confirmed that loading of voltage is avoided in the electric-discharge-hazardous pressure range, or discharge prevention measures are taken in case that is not possible.

(e) Considerations for high pressure gas safety law

① The facility-side pipes in the vacuum vessel of this facility are not subject to the High Pressure Gas Safety Law. When users prepare LN_2/GN_2 panels, make sure they are designed not to be the regulated objects of the law.

(f) The I/F to the facility is to be checked not only by a drawing, but also by visual observation on it.

① I/F to TS supporting bench

② I/F to inner-chamber protruding objects (sensors, work floor, tubes, etc.)

(2) Important matters for using this facility

Here, especially important matters concerning the equipment of this facility are provided for the case of using it. For more detail, refer to the users' manual of each equipment.

(a) General matters

① Users are to mount a TS on a TS supporting bench and control the IR heat source power supply (when used) by themselves, following the users' manual. (The TS supporting bench is brought in and out of the chamber by the facility-side personnel.)

② Especially the domestic products of Aeroglaze Z306 (black), which is used for painting satellites, tend to generate a big amount of outgas, and therefore is to be refrained from being used inside the chamber to prevent contamination. When it is used nevertheless, sufficient baking is required in advance. In case of using paint whose outgas components are unknown, outgas analysis is to be performed on it, followed by the same procedure as above if it is found to generate excessive amount of outgas.

③ The air introduced into the chamber during atmosphere return passes through a drier, which generates absorption heat from the absorbent filled inside. That absorption heat together with the compression heat generated from the introduced air sometimes raises the temperature of air introduced into the chamber (the level of the temperature rise depends on the outdoor temperature and humidity, reaching highest in summer.) Users are to pay attention to this point when performing a test on a temperature-sensitive TS, taking necessary measures for it.

(b) Chamber system

① When feed-through flanges such as a waveguide or a connector are used on the chamber nozzle for users, they are to be subject to the prior checking on leakage from their vacuum-sealed parts.

② The hard ports being made of SUS304, users are to watch out for “seizure” if they prepare screws that are SUS products whose surfaces are not coated. In case an SUS screw is thrusted into the helisert of the hard port, enough caution is required to do it by hand at first, for example.

③ Emergency stop switch

This facility has emergency stop switches, which abort all the facilities when emergency stop is needed (ex. a person is locked into the chamber.) Users are to check the actual switch with their own eyes before using the facility.

・ Emergency stop switch inside chamber
The “switch” consists of the receptacle and plug of an MS connector; the contact point is disconnected when the plug is pulled out, which activates the interlock to abort the facility. In case someone was locked into the chamber, he or she has to pull out the switch. The location of the switch is shown in Figure 4-5.

・ Emergency stop switch inside control room
It is a button-type switch, which aborts all the facilities when its protection pin is pulled out and the button is pressed. The location of the switch is shown in Figures 4-6 and 4-7.

・ Emergency stop switch in preparation room
It is a button-type switch, which aborts all the facilities when its protection pin is pulled out and the button is pressed. The location of the switch is shown in Figures 4-6 and 4-8.

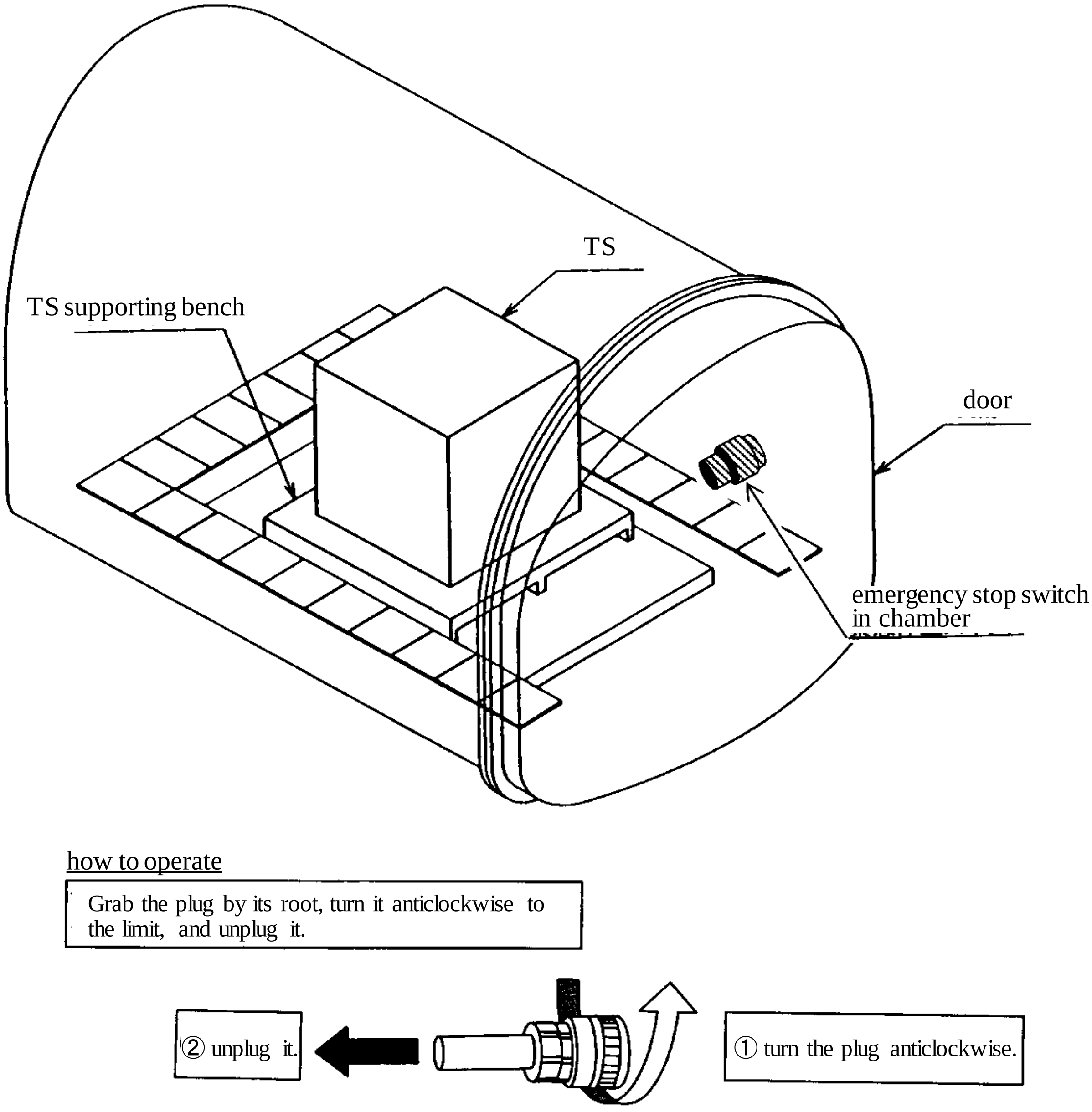
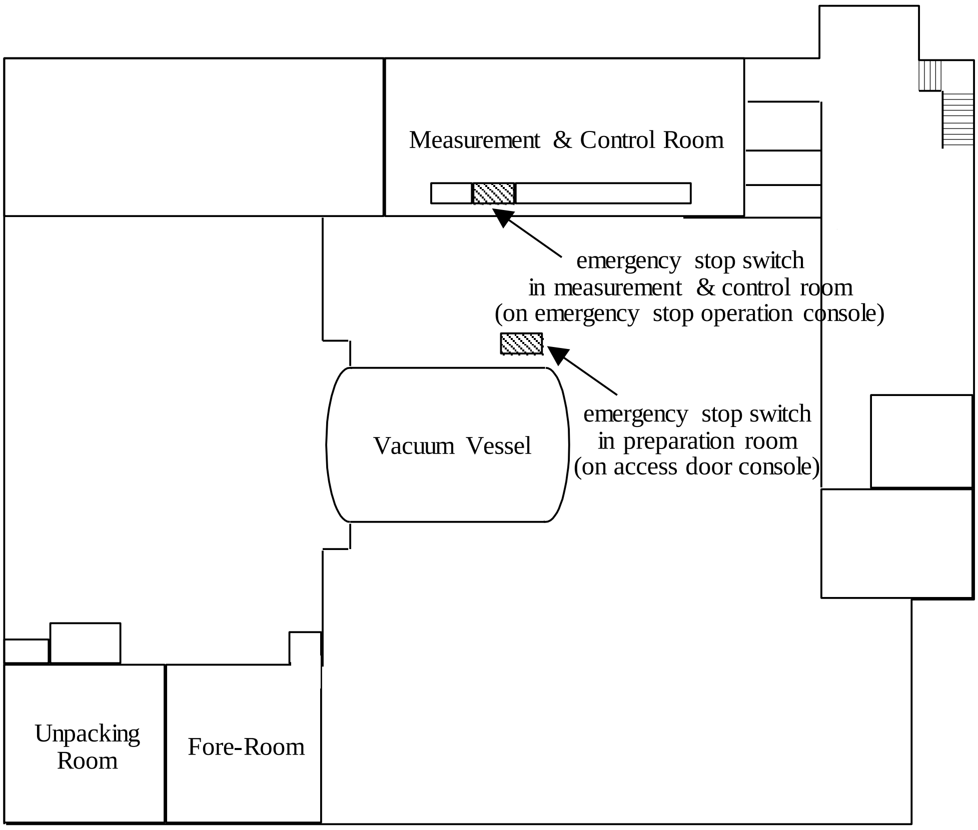


Figure 4-5 Emergency Stop Switch inside Chamber



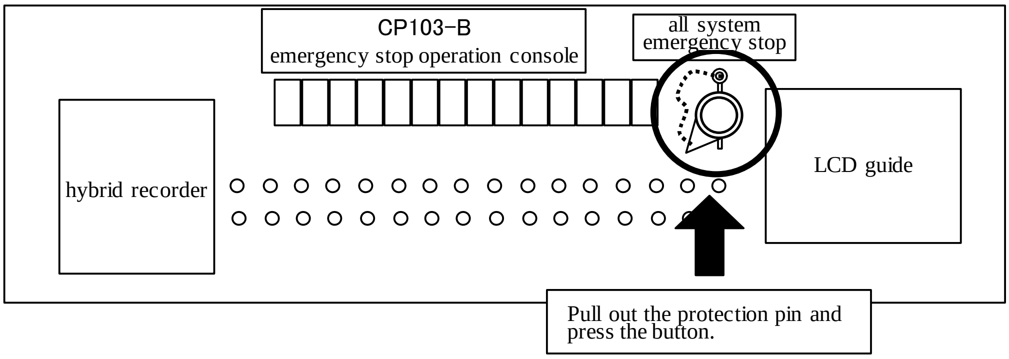


Figure 4-6 Locations of Emergency Stop Switches in Preparation Room and Measurement & Control Room

Figure 4-7 Location of Emergency Stop Switch on Emergency Stop Console Panel in Measurement & Control Room

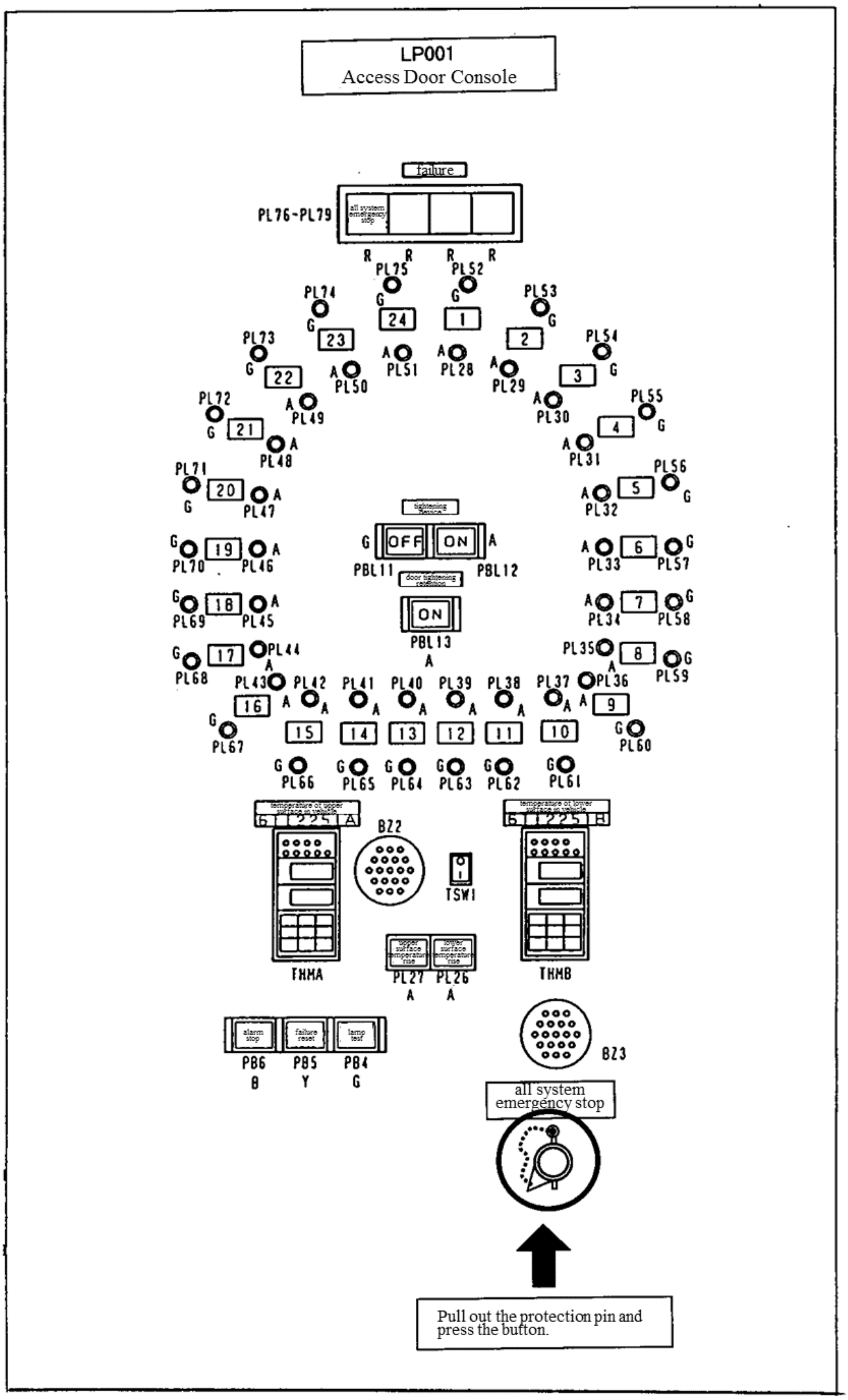


Figure 4-8 Position of Emergency Stop Switch on Preparation Room Access Door Console Panel

4.5. Documents to be Submitted at K/O Meeting

The following documents are to be submitted to the personnel in charge of the facility at the K/O meeting.

- Test implementation plan
- Requirements for the facility (cf. Table 4-3)
- List of nonmetallic articles brought into chamber (cf. Table 4-4)

Table 4-3 Requirements for Facility

>>>These requirements are to be submitted at K/O meeting to the personnel in charge of operating the facility.<<<

6mφ Radiometer Space Chamber

name of test			documentation date： Year Month Day
facility users' name			note
test conditions, etc.	inner-chamber pressure	Pa or less	
	discharge-hazardous range	Pa～ Pa	
	shroud temperature	K or lower	
	environment of clean room (preparation room)	temperature：	23 ± 3℃
		humidity：	30 ~ 60％
		cleanliness：	ISO7 [ISO14644] (class M5.5, equivalent of class 10,000 [FED-STD-209E])
test method, used equipment, etc.	test mode	mode：	
	type of test specimen supporting bench	w/ cooling panel ・ w/o cooling panel	
	power supplies for heat sources	6mφ 60W power supply rack -1：	
		6mφ 2,kW power supply rack -1：	
		6mφ 2,kW power supply rack -2：	
		6mφ 3 kW power supply rack -1：	
	LN_2 (GN_2) for test specimen	not use ／ use	
	UPS for test specimen	not use ／ use	
	vibration analyzer	not use ／ use	
	accelerometer	not use ／ use	
		393M33：	
		393M12：	
		393M31：	
	clean booth	not use ／ use	
	TQCM	not use ／ use______(qty)	

Table 4-4 List of Nonmetallic Articles Brought into Space Chamber

>>>This list is to be submitted at K/O meeting to the personnel in charge of operating the facility.<<<

name of test: **test period:** ～

component	material	application purpose	used amount	TML	CVCM	track record of use
1. test specimen						
2. jig						

Note 1) It is the basic rule that a test specimen and all the jigs are put through baking in another facility before performing a test on them, unless they are true with the cases as below.

・A thermal vacuum test has been already performed on the test specimen and jigs, and the nonexistence of outgas from them is apparent.
・When baking can be proved unnecessary from this list. In that case, never fail to write in the TML and CVCM of the materials.

Note 2) The materials are to accompany their trade names and model numbers.
Note 3) When the used amount of materials is not clear, write in the maximum amount. For silicone grease, for example, 50 g × 2 would be written. When the amount is just a little, write so.
Note 4) If baking is not necessary, provide the basis for that. ex) The amount is just a little, being in the specified levels of both TML and CVCM.

Appendix A Correspondence Table of Channels between Terminal Boards inside Vessel and Data Loggers

Table A-1 Correspondence Table of Channels between Terminal Boards inside Vessel and Data Loggers (1/5)

ch serial#	connectors on inner-vessel terminal boards side					
	#	connector	CH	PIN	material	connector model#
1	1	C1	1	A	copper	AFD56-16-26SN
				B	constantan	
2			2	D	copper	
				C	constantan	
3			3	F	copper	
				E	constantan	
4			4	H	copper	
				G	constantan	
5			5	c	copper	
				J	constantan	
6			6	K	copper	
				R	constantan	
7			7	M	copper	
				L	constantan	
8			8	N	copper	
				P	constantan	
9			9	S	copper	
				T	constantan	
10			10	U	copper	
				V	constantan	
11			11	W	copper	
				X	constantan	
12			12	Z	copper	
				Y	constantan	
13	2	C2	1	A	copper	AFD56-16-26SN
				B	constantan	
14			2	D	copper	
				C	constantan	
15			3	F	copper	
				E	constantan	
16			4	H	copper	
				G	constantan	
17			5	c	copper	
				J	constantan	
18			6	K	copper	
				R	constantan	
19			7	M	copper	
				L	constantan	
20			8	N	copper	
				P	constantan	
21			9	S	copper	
				T	constantan	
22			10	U	copper	
				V	constantan	
23			11	W	copper	
				X	constantan	
24			12	Z	copper	
				Y	constantan	
25	3	C3	1	A	copper	AFD56-16-26SN
				B	constantan	
26			2	D	copper	
				C	constantan	
27			3	F	copper	
				E	constantan	
28			4	H	copper	
				G	constantan	
29			5	c	copper	
				J	constantan	
30			6	K	copper	
				R	constantan	
31			7	M	copper	
				L	constantan	
32			8	N	copper	
				P	constantan	
33			9	S	copper	
				T	constantan	
34			10	U	copper	
				V	constantan	
35			11	W	copper	
				X	constantan	
36			12	Z	copper	
				Y	constantan	

ch serial#	connectors on inner-vessel terminal boards side					
	#	connector	CH	PIN	material	connector model#
37	4	C4	1	A	copper	AFD56-16-26SN
				B	constantan	
38			2	D	copper	
				C	constantan	
39			3	F	copper	
				E	constantan	
40			4	H	copper	
				G	constantan	
41			5	c	copper	
				J	constantan	
42			6	K	copper	
				R	constantan	
43			7	M	copper	
				L	constantan	
44			8	N	copper	
				P	constantan	
45			9	S	copper	
				T	constantan	
46			10	U	copper	
				V	constantan	
47			11	W	copper	
				X	constantan	
48			12	Z	copper	
				Y	constantan	
49	5	C5	1	A	copper	AFD56-16-26SN
				B	constantan	
50			2	D	copper	
				C	constantan	
51			3	F	copper	
				E	constantan	
52			4	H	copper	
				G	constantan	
53			5	c	copper	
				J	constantan	
54			6	K	copper	
				R	constantan	
55			7	M	copper	
				L	constantan	
56			8	N	copper	
				P	constantan	
57			9	S	copper	
				T	constantan	
58			10	U	copper	
				V	constantan	
59			11	W	copper	
				X	constantan	
60			12	Z	copper	
				Y	constantan	
61	6	C6	1	A	copper	AFD56-16-26SN
				B	constantan	
62			2	D	copper	
				C	constantan	
63			3	F	copper	
				E	constantan	
64			4	H	copper	
				G	constantan	
65			5	c	copper	
				J	constantan	
66			6	K	copper	
				R	constantan	
67			7	M	copper	
				L	constantan	
68			8	N	copper	
				P	constantan	
69			9	S	copper	
				T	constantan	
70			10	U	copper	
				V	constantan	
71			11	W	copper	
				X	constantan	
72			12	Z	copper	
				Y	constantan	

Table A-1 Correspondence Table of Channels between Terminal Boards inside Vessel and Data Loggers

(2/5)

ch serial#	connectors on inner-vessel terminal boards side					
	#	connector	CH	PIN	material	connector model#
73	7	C7	1	A	copper	AFD56-16-26SN
				B	constantan	
74			2	D	copper	
				C	constantan	
75			3	F	copper	
				E	constantan	
76			4	H	copper	
				G	constantan	
77			5	c	copper	
				J	constantan	
78			6	K	copper	
				R	constantan	
79			7	M	copper	
				L	constantan	
80			8	N	copper	
				P	constantan	
81			9	S	copper	
				T	constantan	
82			10	U	copper	
				V	constantan	
83			11	W	copper	
				X	constantan	
84			12	Z	copper	
				Y	constantan	
85	8	C8	1	A	copper	AFD56-16-26SN
				B	constantan	
86			2	D	copper	
				C	constantan	
87			3	F	copper	
				E	constantan	
88			4	H	copper	
				G	constantan	
89			5	c	copper	
				J	constantan	
90			6	K	copper	
				R	constantan	
91			7	M	copper	
				L	constantan	
92			8	N	copper	
				P	constantan	
93			9	S	copper	
				T	constantan	
94			10	U	copper	
				V	constantan	
95			11	W	copper	
				X	constantan	
96			12	Z	copper	
				Y	constantan	
97	9	C9	1	A	copper	AFD56-16-26SN
				B	constantan	
98			2	D	copper	
				C	constantan	
99			3	F	copper	
				E	constantan	
100			4	H	copper	
				G	constantan	
101			5	c	copper	
				J	constantan	
102			6	K	copper	
				R	constantan	
103			7	M	copper	
				L	constantan	
104			8	N	copper	
				P	constantan	
105			9	S	copper	
				T	constantan	
106			10	U	copper	
				V	constantan	
107			11	W	copper	
				X	constantan	
108			12	Z	copper	
				Y	constantan	
109	10	C10	1	A	copper	AFD56-16-26SN
				B	constantan	
110			2	D	copper	
				C	constantan	
111			3	F	copper	
				E	constantan	
112			4	H	copper	
				G	constantan	
113			5	c	copper	
				J	constantan	
114			6	K	copper	
				R	constantan	
115			7	M	copper	
				L	constantan	
116			8	N	copper	
				P	constantan	
117			9	S	copper	
				T	constantan	
118			10	U	copper	
				V	constantan	
119			11	W	copper	
				X	constantan	
120			12	Z	copper	
				Y	constantan	
121	11	C11	1	A	copper	AFD56-16-26SN
				B	constantan	
122			2	D	copper	
				C	constantan	
123			3	F	copper	
				E	constantan	
124			4	H	copper	
				G	constantan	
125			5	c	copper	
				J	constantan	
126			6	K	copper	
				R	constantan	
127			7	M	copper	
				L	constantan	
128			8	N	copper	
				P	constantan	
129			9	S	copper	
				T	constantan	
130			10	U	copper	
				V	constantan	
131			11	W	copper	
				X	constantan	
132			12	Z	copper	
				Y	constantan	
133	12	C12	1	A	copper	AFD56-16-26SN
				B	constantan	
134			2	D	copper	
				C	constantan	
135			3	F	copper	
				E	constantan	
136			4	H	copper	
				G	constantan	
137			5	c	copper	
				J	constantan	
138			6	K	copper	
				R	constantan	
139			7	M	copper	
				L	constantan	
140			8	N	copper	
				P	constantan	
141			9	S	copper	
				T	constantan	
142			10	U	copper	
				V	constantan	
143			11	W	copper	
				X	constantan	
144			12	Z	copper	
				Y	constantan	

Table A-1 Correspondence Table of Channels between Terminal Boards inside Vessel and Data Loggers (3/5)

ch serial#	connectors on inner-vessel terminal boards side					
	#	connector	CH	PIN	material	connector model#
145	13	C13	1	A	copper	AFD56-16-26SN
				B	constantan	
146			2	D	copper	
				C	constantan	
147			3	F	copper	
				E	constantan	
148			4	H	copper	
				G	constantan	
149			5	c	copper	
				J	constantan	
150			6	K	copper	
				R	constantan	
151			7	M	copper	
				L	constantan	
152			8	N	copper	
				P	constantan	
153			9	S	copper	
				T	constantan	
154			10	U	copper	
				V	constantan	
155			11	W	copper	
				X	constantan	
156			12	Z	copper	
				Y	constantan	
157	14	C14	1	A	copper	AFD56-16-26SN
				B	constantan	
158			2	D	copper	
				C	constantan	
159			3	F	copper	
				E	constantan	
160			4	H	copper	
				G	constantan	
161			5	c	copper	
				J	constantan	
162			6	K	copper	
				R	constantan	
163			7	M	copper	
				L	constantan	
164			8	N	copper	
				P	constantan	
165			9	S	copper	
				T	constantan	
166			10	U	copper	
				V	constantan	
167			11	W	copper	
				X	constantan	
168			12	Z	copper	
				Y	constantan	
169	15	C15	1	A	copper	AFD56-16-26SN
				B	constantan	
170			2	D	copper	
				C	constantan	
171			3	F	copper	
				E	constantan	
172			4	H	copper	
				G	constantan	
173			5	c	copper	
				J	constantan	
174			6	K	copper	
				R	constantan	
175			7	M	copper	
				L	constantan	
176			8	N	copper	
				P	constantan	
177			9	S	copper	
				T	constantan	
178			10	U	copper	
				V	constantan	
179			11	W	copper	
				X	constantan	
180			12	Z	copper	
				Y	constantan	

ch serial#	connectors on inner-vessel terminal boards side					
	#	connector	CH	PIN	material	connector model#
181	16	C16	1	A	copper	AFD56-16-26SN
				B	constantan	
182			2	D	copper	
				C	constantan	
183			3	F	copper	
				E	constantan	
184			4	H	copper	
				G	constantan	
185			5	c	copper	
				J	constantan	
186			6	K	copper	
				R	constantan	
187			7	M	copper	
				L	constantan	
188			8	N	copper	
				P	constantan	
189			9	S	copper	
				T	constantan	
190			10	U	copper	
				V	constantan	
191			11	W	copper	
				X	constantan	
192			12	Z	copper	
				Y	constantan	
193	17	C17	1	A	copper	AFD56-16-26SN
				B	constantan	
194			2	D	copper	
				C	constantan	
195			3	F	copper	
				E	constantan	
196			4	H	copper	
				G	constantan	
197			5	c	copper	
				J	constantan	
198			6	K	copper	
				R	constantan	
199			7	M	copper	
				L	constantan	
200			8	N	copper	
				P	constantan	
201			9	S	copper	
				T	constantan	
202			10	U	copper	
				V	constantan	
203			11	W	copper	
				X	constantan	
204			12	Z	copper	
				Y	constantan	
205	18	C18	1	A	copper	AFD56-16-26SN
				B	constantan	
206			2	D	copper	
				C	constantan	
207			3	F	copper	
				E	constantan	
208			4	H	copper	
				G	constantan	
209			5	c	copper	
				J	constantan	
210			6	K	copper	
				R	constantan	
211			7	M	copper	
				L	constantan	
212			8	N	copper	
				P	constantan	
213			9	S	copper	
				T	constantan	
214			10	U	copper	
				V	constantan	
215			11	W	copper	
				X	constantan	
216			12	Z	copper	
				Y	constantan	

Table A-1 Correspondence Table of Channels between Terminal Boards inside Vessel and Data Loggers (4/5)

ch serial#	connectors on inner-vessel terminal boards side					
	#	connector	CH	PIN	material	connector model#
217	19	C19	1	A	copper	AFD56-16-26SN
				B	constantan	
218			2	D	copper	
				C	constantan	
219			3	F	copper	
				E	constantan	
220			4	H	copper	
				G	constantan	
221			5	c	copper	
				J	constantan	
222			6	K	copper	
				R	constantan	
223			7	M	copper	
				L	constantan	
224			8	N	copper	
				P	constantan	
225			9	S	copper	
				T	constantan	
226			10	U	copper	
				V	constantan	
227			11	W	copper	
				X	constantan	
228			12	Z	copper	
				Y	constantan	
229	20	C20	1	A	copper	AFD56-16-26SN
				B	constantan	
230			2	D	copper	
				C	constantan	
231			3	F	copper	
				E	constantan	
232			4	H	copper	
				G	constantan	
233			5	c	copper	
				J	constantan	
234			6	K	copper	
				R	constantan	
235			7	M	copper	
				L	constantan	
236			8	N	copper	
				P	constantan	
237			9	S	copper	
				T	constantan	
238			10	U	copper	
				V	constantan	
239			11	W	copper	
				X	constantan	
240			12	Z	copper	
				Y	constantan	
241	21	C21	1	A	copper	AFD56-16-26SN
				B	constantan	
242			2	D	copper	
				C	constantan	
243			3	F	copper	
				E	constantan	
244			4	H	copper	
				G	constantan	
245			5	c	copper	
				J	constantan	
246			6	K	copper	
				R	constantan	
247			7	M	copper	
				L	constantan	
248			8	N	copper	
				P	constantan	
249			9	S	copper	
				T	constantan	
250			10	U	copper	
				V	constantan	
251			11	W	copper	
				X	constantan	
252			12	Z	copper	
				Y	constantan	

ch serial#	connectors on inner-vessel terminal boards side					
	#	connector	CH	PIN	material	connector model#
253	22	C22	1	A	copper	AFD56-16-26SN
				B	constantan	
254			2	D	copper	
				C	constantan	
255			3	F	copper	
				E	constantan	
256			4	H	copper	
				G	constantan	
257			5	c	copper	
				J	constantan	
258			6	K	copper	
				R	constantan	
259			7	M	copper	
				L	constantan	
260			8	N	copper	
				P	constantan	
261			9	S	copper	
				T	constantan	
262			10	U	copper	
				V	constantan	
263			11	W	copper	
				X	constantan	
264			12	Z	copper	
				Y	constantan	
265	23	C23	1	A	copper	AFD56-16-26SN
				B	constantan	
266			2	D	copper	
				C	constantan	
267			3	F	copper	
				E	constantan	
268			4	H	copper	
				G	constantan	
269			5	c	copper	
				J	constantan	
270			6	K	copper	
				R	constantan	
271			7	M	copper	
				L	constantan	
272			8	N	copper	
				P	constantan	
273			9	S	copper	
				T	constantan	
274			10	U	copper	
				V	constantan	
275			11	W	copper	
				X	constantan	
276			12	Z	copper	
				Y	constantan	
277	24	C24	1	A	copper	AFD56-16-26SN
				B	constantan	
278			2	D	copper	
				C	constantan	
279			3	F	copper	
				E	constantan	
280			4	H	copper	
				G	constantan	
281			5	c	copper	
				J	constantan	
282			6	K	copper	
				R	constantan	
283			7	M	copper	
				L	constantan	
284			8	N	copper	
				P	constantan	
285			9	S	copper	
				T	constantan	
286			10	U	copper	
				V	constantan	
287			11	W	copper	
				X	constantan	
288			12	Z	copper	
				Y	constantan	

Table A-1 Correspondence Table of Channels between Terminal Boards inside Vessel and Data Loggers (5/5)

ch serial#	connectors on inner-vessel terminal boards side					
	#	connector	CH	PIN	material	connector model#
289	25	C25	1	A	copper	AFD56-16-26SN
				B	constantan	
290			2	D	copper	
				C	constantan	
291			3	F	copper	
				E	constantan	
292			4	H	copper	
				G	constantan	
293			5	c	copper	
				J	constantan	
294			6	K	copper	
				R	constantan	
295			7	M	copper	
				L	constantan	
296			8	N	copper	
				P	constantan	
297			9	S	copper	
				T	constantan	
298			10	U	copper	
				V	constantan	
299			11	W	copper	
				X	constantan	
300			12	Z	copper	
				Y	constantan	
301	26	C26	1	A	copper	AFD56-16-26SN
				B	constantan	
302			2	D	copper	
				C	constantan	
303			3	F	copper	
				E	constantan	
304			4	H	copper	
				G	constantan	
305			5	c	copper	
				J	constantan	
306			6	K	copper	
				R	constantan	
307			7	M	copper	
				L	constantan	
308			8	N	copper	
				P	constantan	
309			9	S	copper	
				T	constantan	
310			10	U	copper	
				V	constantan	
311			11	W	copper	
				X	constantan	
312			12	Z	copper	
				Y	constantan	
313	27	C27	1	A	copper	AFD56-16-26SN
				B	constantan	
314			2	D	copper	
				C	constantan	
315			3	F	copper	
				E	constantan	
316			4	H	copper	
				G	constantan	
317			5	c	copper	
				J	constantan	
318			6	K	copper	
				R	constantan	
319			7	M	copper	
				L	constantan	
320			8	N	copper	
				P	constantan	
321			9	S	copper	
				T	constantan	
322			10	U	copper	
				V	constantan	
323			11	W	copper	
				X	constantan	
324			12	Z	copper	
				Y	constantan	

ch serial#	connectors on inner-vessel terminal boards side					
	#	connector	CH	PIN	material	connector model#
325	28	C28	1	A	copper	AFD56-16-26SN
				B	constantan	
326			2	D	copper	
				C	constantan	
327			3	F	copper	
				E	constantan	
328			4	H	copper	
				G	constantan	
329			5	c	copper	
				J	constantan	
330			6	K	copper	
				R	constantan	
331			7	M	copper	
				L	constantan	
332			8	N	copper	
				P	constantan	
333			9	S	copper	
				T	constantan	
334			10	U	copper	
				V	constantan	
335			11	W	copper	
				X	constantan	
336			12	Z	copper	
				Y	constantan	